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A Practical Handbook

BY

J. BLUMFELD, M.D. Cantab.

Senior Anæsthetist to St. George's Hospital; Hon. Anæsthetist to St. Mary's Hospital, and to the Grosvenor Hospital for Women and Children, London

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PREFACE TO SECOND EDITION

CONTINUED demand for this little book affords me the opportunity of making it more complete by the addition of a short chapter upon the use of ethyl chloride. Otherwise there is little alteration or addition, beyond some reference to recent work upon chloroform inhalers and an account of the use of ethyl chloride as a preliminary to ether.

J. B.

CAVENDISH PLACE,
May, 1906.

PREFACE TO FIRST EDITION

The study of anæsthetics being now insisted upon as part of the student's curriculum before admission to some of the final examinations in medicine and surgery, a small book may be serviceable containing a brief account of the principles upon which the common anæsthetics are selected and administered, and of the practical details involved. In so slight a work I have not thought it necessary to give full reference to authorities, but I wish here to specially acknowledge the kind advice of Dr. Frederic Hewitt, and the free use made of his recent writings.

J. BLUMFELD.

October, 1902.

CONTENTS

ANÆSTHETICS

CHAPTER I

NATURE AND ACTION OF THE COMMON ANÆSTHETICS

General anæsthesia for surgical purposes is a condition in which—

(1) Absolute unconsciousness and insensibility to pain,

(2) Loss of power over the voluntary muscles,

(3) Diminution of reflex excitability

are associated with unimpaired performance of the vital functions of circulation and respiration.

The substances in common use for the production of general anæsthesia are—

(i.) Chloroform, $CHCl_3$ (trichlormethane, perchloride of formyl, dichlorinated chloride of methyl).

(ii.) Ether, $(C_2H_5)_2O$ (ethyl oxide, ethylic ether, vinous ether, sulphuric ether).

(iii.) Nitrous oxide, N_2O (nitrogen monoxide, protoxide of nitrogen, laughing gas).

(iv.) Ethyl chloride, ether chloratus, C_2H_5Cl.

At the usual atmospheric pressure and temperature the two first and fourth are liquids, the third a gas. Consequently, nitrous oxide for producing anæsthesia is supplied in strong metal cylinders, which contain it

under great pressure in a liquid state. Besides being used individually, these three anæsthetics may be employed in various successions and in various mixtures. Other substances less frequently employed, and, according to present knowledge, incapable of producing results equally satisfactory with those obtained from the common anæsthetics, are—

(*a*) Ethyl bromide, C_2H_5Br.

(*b*) Ethidene dichloride, CH_3CHCl_2.

(*c*) Amylene, a mixture, the chief ingredient being

(*d*) Pental, C_5H_{10}.

These are mostly unsatisfactory because of the brief nature of the anæsthesia to which they give rise, or because of the danger or imperfect muscular relaxation with which it is accompanied.

The remainder of this chapter is devoted to a brief account of the leading chemical and physiological qualities of the common anæsthetics,* some knowledge of which is essential for the student in his practical application of these agents. The facts given have been determined by experiment or clinical observation, or both.

Chemical Points

I. **Chloroform** is a colourless, transparent, volatile liquid, with a penetrating odour and a sweet, burning taste. It has a blistering action if dropped upon the skin. It is not inflammable as ether is, but its vapour is decomposed by a bare flame, an important point to be remembered in practice. Serious and undesirable effects have arisen from giving chloroform in the neighbourhood of a lighted candle or gas-jet. If this association is unavoidable, the ventilation of the room must be

* This account is taken mainly from Dr. Frederick Hewitt's 'Anæsthetics' (Macmillan, 1901).

specially attended to, so that the decomposition products may escape as easily as possible. Carbony chloride is the chief objectionable product concerned.

Chloroform has a specific gravity of 1·49 at 17° C., and a boiling-point of about 60° C. The density of its vapour is about sixty times that of hydrogen.

Under ordinary circumstances the vapour of chloroform has no separate existence, being always mixed with air. It can exist in a pure state only if the temperature is raised to 60° C. (140° F.), or if the pressure of the atmosphere is removed by the air-pump.

Chloroform is liable to alteration if exposed to sunlight and air, carbonyl chloride being formed. It is to be kept, therefore, in small, stoppered bottles in a cool, dark place. If chloroform is not kept in the dark, the bottles containing it should be coloured dark red. Chloroform to be used for anæsthetic purposes should be—

1. Neutral to test-paper.
2. Transparent and colourless.
3. Of specific gravity and boiling-point, as described.
4. Of a non-irritating odour.
5. Leaving no residue if allowed to evaporate from an open dish.
6. Free from brownish coloration if shaken with concentrated sulphuric acid, or if heated to boiling-point with caustic potash.

II. **Ether** is a transparent, colourless, very volatile liquid, with a pungent odour and burning taste. Ether vapour is extremely inflammable, and, when mixed with air, explodes violently if near a flame. The ether bottle is, therefore, never to be placed near a fire or gas-jet, nor must ether be poured out in such a neighbourhood. In cases where the actual cautery is used ether must not be employed, or, if it has been, time must be

allowed for all the ether vapour to have disappeared from the patient before the cautery is applied.

Ether is neutral to test-paper, has specific gravity of about ·723 at 12·5° C., and boils at 35·6° C. (96° F.). There are two kinds of ether which may be used for anæsthetic purposes—(i.) Æther purificatus (off.), specific gravity not above ·722, and not below ·720, obtained from pure rectified spirit; and (ii.) rectified ether, specific gravity ·720, obtained from methylated spirit.

After using both frequently, and on many occasions employing upon the same patient first one ether, and at a second operation the other, I am of opinion that the results differ to an extent that may be disregarded. The rectified ether is much cheaper.

III. **Nitrous Oxide** is a colourless, transparent gas, with sweetish odour and taste. When pure it is entirely non-irritating, for which reason it is so extremely useful as a preliminary to the introduction of the irritating vapour of ether. It has a specific gravity of 1·5.

Liquefaction of nitrous oxide takes place under a pressure of fifty atmospheres at 7° C. Liquefied nitrous oxide is a colourless body, with specific gravity of ·936 at 0° C. and boiling-point – 87·9° C. under a pressure of 767·3 mm. Hg.

Roughly speaking, 15 ounces by weight of liquefied nitrous oxide furnish 50 gallons of the gas, as from the cylinders in common use. Intense cold is caused by the conversion of the liquid into the gas, and in this way freezing may take place about a gas-cylinder.

If the cylinder is securely jointed, liquefied nitrous oxide may be preserved in it practically for an indefinite time. Nitrous oxide is not easily decomposed.

Ethyl Chloride is a colourless, very volatile liquid, with an odour suggestive of, but less irritating than, that

of ether. When pure, it evaporates without residue, and has no acid reaction. Ethyl chloride is inflammable, and therefore not to be used near a naked flame or fire. Cauterization of the nose, however, has been performed under its influence, with no untoward result. The boiling-point is about 12° C., and the specific gravity ·917 at 8° C.* Ethyl chloride is supplied in hermetically-closed glass tubes, from which it is liberated in the form of a spray by means of spring taps of various kinds. One of the best forms of tap and tube is that supplied by Duncan and Flockhart, and the ethyl chloride contained is of the purest kind (Fig. 1).

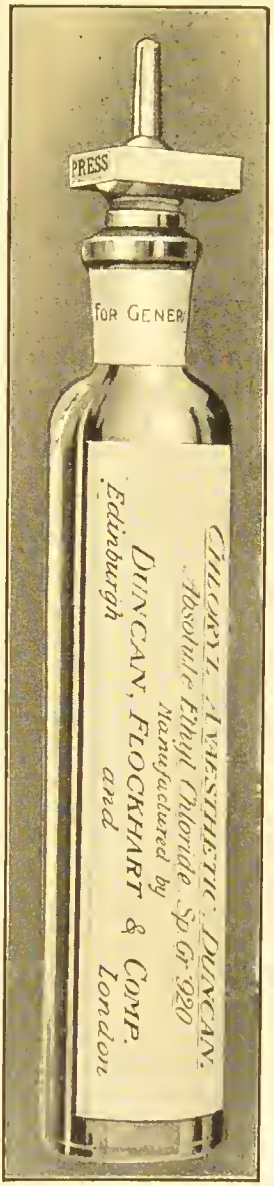

FIG. 1.

Physiological Points

The anæsthetic effects of the vapours of the drugs just described are produced by their action upon the brain and nervous system generally. The drugs are brought into contact with the nervous system by means of the circulation, and they are introduced into the circulating blood by being inspired into the lungs, from the alveoli of which they are taken up into the pulmonary capillaries,

* McCardie, *Lancet*, October 7, 1905, p. 1023.

and so by way of the left side of the heart into the general circulation.

It is possible, of course, to introduce anæsthetic vapours into the circulation by other routes. Ether, for instance, has been frequently administered by way of the rectal mucous membrane, but at present the commonly-used method of allowing the vapours to be inhaled offers the greatest facility for producing the desired effects, and no other way will be here considered.

Nitrous oxide can be breathed pure, but as it cannot furnish the tissues with oxygen, a limit to its respirability arises from the advent of asphyxia. The gas has no other deleterious action upon the human body, differing in this respect from chloroform and ether, which are both nerve poisons. These two, again, differ in the extent of their poisonous action, chloroform being, both according to experiment and clinical observation, about seven times as strong a poison as ether. Some parts of the nervous system are affected earlier and more easily than others. The vital centres in the medulla hold out and allow respiration and circulation to continue after the rest of the nervous system is under the influence of the anæsthetic. By giving extreme doses the respiration and circulation too may be paralyzed, and death brought about. This is achieved much more easily with chloroform than with ether, mainly because, besides its action upon the brain, chloroform has a directly depressing action upon the muscles of the heart and arteries, and causes a lowered blood-pressure. Ether has, on the contrary, a stimulating effect upon the circulation, at any rate at first, and, practically speaking, can only cause death by producing respiratory paralysis, for which event it must be given to an extreme degree.

All Anæsthetics may give rise to Respiratory Embarrassment.—Several factors may contribute to this :

1. Swelling of the tongue and faucial structures and increased secretion of mucus and saliva—more marked with ether.

2. Spasm of the muscles of jaws and neck—chiefly in incomplete anæsthesia. During the induction of anæsthesia, ether and chloroform and ethyl chloride give rise to muscular spasm. The extent to which this occurs varies greatly according to the nature of the subject.

In light degrees of anæsthesia, too, swallowing movements, retching and vomiting, may interfere with proper performance of respiration. The two latter symptoms are evoked if too concentrated a vapour is given early, but they may also accompany too slow an administration.

At the beginning of the administration there may be, with nervous or hysterical subjects, prolonged holding of the breath, or a protracted cry, either of which interferes with proper breathing.

3. Sucking in of the tongue with inspiration, so as to obstruct the glottis.

4. In edentulous cases, falling in of the cheeks, with inspiration.

5. In dyspnœic cases, paralysis of the extraordinary muscles of respiration, where these are necessary for adequate performance of respiration.

6. Depression of the respiratory centre, either through toxic action of the drug upon the medulla, or indirectly through lowered circulation causing the centre to be insufficiently supplied with blood ; this mostly occurs in deep chloroform anæsthesia.

When anæsthesia is established, respiration is still

subject to many influences. The reflex sensibility of the respiratory centre, which, as physiology shows, responds to stimulus brought by almost any afferent nerve, remains active to a great extent.

Thus the initial incision of an operation generally causes the breathing to become deeper and quicker. Forcible stretching of sphincters, dragging on internal organs, and a variety of manipulations in the course of different operations, particularly those involving the deep structures of the neck and of the pelvis, all may reflexly cause hurried or gasping breathing, or a temporary suspension of respiration. A more audible and quicker respiration often indicates the approach of vomiting while an operation is in progress. When operation is over, recovery is generally preceded by very quiet, shallow breathing. The introduction of any asphyxial element, as the addition of carbon dioxide through re-breathing, or the presence of mechanical obstruction in the upper air-passages, causes exaggerated breathing.

Numerous experiments have been made to determine:

(i.) What strength of chloroform vapour may be considered safe.

(ii.) How death by chloroform comes about.

The conditions of the laboratory are different from those of the operating theatre, and human beings differ from the animals experimented upon; but, nevertheless, some of the facts regarding the action of chloroform, which have been experimentally determined, must always be borne in mind by the practical anæsthetist. He must never overlook, however, the *special proclivity for mechanical obstructive respiratory difficulty to arise in the human subject under anæsthetics.* This is a most im-

portant element of danger that is largely absent in the case of the lower animals. It is less present in infants than adults, probably owing to their inferior muscular development, a fact which, perhaps, gave rise to the false impression that children were immune from danger through chloroform.

It may be regarded as established that—

(*a*) Danger from chloroform is greatest in the early stage of administration. This is chiefly because (1) excitability of the vagus inhibitory mechanism is then increased (Embley); (2) tendency to mechanical obstruction to respiration is more likely then than when anæsthesia is established. Imperfect respiration increases the chance of dangerous vagus inhibition, and greatly adds to the danger arising from the direct action of chloroform upon the heart. Any tendency to asphyxia through obstructed breathing throws strain upon the right side of the heart, and the chloroform, imprisoned through the hampered breathing, adds to the heart's difficulty by its depressing action on the cardiac muscle. Moreover, extreme and widespread spasm of muscles may in the early stage of chloroform inhalation add greatly to the work of the heart.

(*b*) Failure of respiration is mainly due to fall of blood-pressure, and happens as frequently after as before stopping of the heart (Embley).

(*c*) Fall of pressure is largely brought about by the directly depressant action of chloroform upon the muscle-fibre of the heart and arteries.

(*d*) There is special danger in the sudden introduction of strong chloroform vapour.

(*e*) Temporary respiratory failure may occur with no apparent circulatory depression.

(*f*) Chloroform vapour stronger than about 4 per cent.

easily gives rise to danger. When anæsthesia is once established, a considerably weaker vapour than this—viz., one of 1 to 2 per cent.—is usually enough.

(*g*) Chloroform rapidly abolishes the vascular mechanisms which compensate for the effect of gravity. The principal effect is a paralytic state of the splanchnic vasomotor mechanism leading to accumulation of blood within the splanchnic area (Hill).

(*h*) Whether deaths from chloroform occur from primary circulatory failure or not, the respiratory failure that occurs is always accompanied in dangerous cases by circulatory failure. But as the earliest easily observed indication of circulatory depression may be respiratory feebleness, or failure, the clinical rule holds good that *under chloroform the breathing is to be constantly and closely watched.* Moreover, but slight mechanical obstruction to breathing, such as is particularly liable to arise under chloroform, may convert an amount of chloroform that is harmless while breathing is regular into a source of the greatest danger. The obvious and all-important lessons that follow from these facts are :

1. Give chloroform gradually.

2. Give chloroform freely diluted with air.

3. Maintain perfectly unimpeded respiration throughout the administration; keep constant watch upon the manner in which respiration goes on.

4. Pay attention to the position of the patient, so that this shall not add to the danger arising from a lowered blood-pressure and dilated splanchnic area.

5. Observe the condition of the circulation as shown by the pulse.

The heart and vascular system may, for practical purposes, be regarded as unaffected by ether, except that, at first, the heart's action is stimulated. It must be re-

membered, however, that the prolonged administration of any anæsthetic leads to the symptoms of shock, and that the element of time is therefore always of importance when a human being is subjected to operation under anæsthetics. Experimental work with ethyl chloride shows that this drug given in lethal doses leads to death through respiratory paralysis, without direct effect upon the circulatory system. Clinically, however, this is not entirely borne out, cases of apparently primary circulatory failure during, or just after, ethyl chloride inhalation being reported.

Since the time of Snow the effects produced by chloroform as the subject passes from complete consciousness through complete anæsthesia to paralysis of the vital centres have been divided into four stages, and the division of symptoms is applied also to the action of ether. Although with modern methods of administration, in the case of 'gas and ether,' at any rate, it is quite impossible to recognise these stages in the smooth passage from consciousness to anæsthesia that is commonly provided by a skilled anæsthetist, yet the student will be assisted by a knowledge of these recognised divisions of effects. The following table, showing the degrees in the action of the chief general anæsthetics, is copied from Dr. Frederick Hewitt's book. In recovering from the anæsthetics these stages are to a large extent again passed through, but in the reverse order.

Stage 1.—Disordered Consciousness and Analgesia

Excessive ideation; disturbance of judgment, control, and volition.

Analgesia.

Vertigo and loss of power of maintaining equilibrium.

Pleasurable or distressing sensations.

Disturbances of common sensibility and of special senses.

Misinterpretation of external impressions.

Emotional disturbances—*e.g.*, laughter and crying; reflexes well marked and often exaggerated; sensory stimuli may produce co-ordinated and apparently purposive movements.

Loss of power of remembering (fixing) sensory impressions.

Dreams.

Rise of blood-pressure and increase of cardiac action.

Respiration increased, but regular and free, unless interfered with by emotional causes or by direct irritation of anæsthetic, inducing cough, 'holding of breath,' laryngeal spasm, retching or vomiting.

Pupils dilated.

Stage 2.—Unconscious Reflex Activity

Complete loss of consciousness.

Delirium; articulate speech passing into unintelligible muttering.

Respiration still deeper and quicker than normal; often irregular and impeded by

General tonic muscular spasm, deglutition, closure of glottis, spasm of jaws, etc.

Clonic muscular spasm.

Reflexes still persist, but motor results of stimuli devoid of purposive character.

Inarticulate phonated (expiratory) sounds.

Coughing, retching, vomiting.

Heart's action still excited (much dependent on character of breathing).

Pupils smaller.

Stage 3.—Surgical Anæsthesia or Coma

General muscular relaxation; breathing regular, often softly snoring or stertorous.

Decrease of respiratory exchanges; fall of temperature.

Increasing fall of blood-pressure (chloroform).

Heart's action weakened; variable degree of cardiac dilatation.

Loss of conjunctival, pharyngeal, laryngeal, patellar, and most, but not all, reflexes.

Pupils larger.

Stage 4.—Bulbar Paralysis

Loss of bladder, rectal, peritoneal, and respiratory reflexes.

Loss of cardiac reflexes (?).

Breathing becomes shallow.

Increasing lividity or pallor.

Breathing ceases (paralysis of respiratory centres).

Paralysis of vasomotor centre (?).

Feeble, irregular cardiac action; paralysis of cardiac ganglia and myocardium.

Widely dilated pupils.

Separation of eyelids.

Death.

CHAPTER II

NITROUS OXIDE

Nitrous oxide may be given pure, or in combination with oxygen, or air, or ether. When combined with ether (p. 40) it is used mainly as a preliminary to the anæsthesia of the more powerful drug. Many short operations, however, may be conveniently done during an anæsthesia which is due partly to nitrous oxide and partly to ether. Nitrous oxide is rarely given in combination with chloroform; I do not recommend the practice. Whether alone or in combination, nitrous oxide is only to be used for operations which are short, and of a kind in which complete muscular relaxation and immobility are not essential. In spite of the fact that very long administrations of 'gas and oxygen' and 'gas and air' have been successfully conducted, the disadvantages of using this anæsthetic for long operations more than outweigh the undoubted advantages which it offers as regards safety over ether and chloroform. The anæsthesia obtainable by nitrous oxide gas is of a much lighter nature than that from ether and chloroform. Consequently, there is not the same certainty that there will be freedom from movement and other reflex effects during operation. Moreover, with strong subjects it is impossible to be certain even of maintaining anæsthesia. It is difficult, too, to avoid occasional moments of recovery, the margin between

anæsthesia and consciousness being so narrow a one. Moreover, after long administrations of nitrous oxide there is not always that freedom from after-effects which it was hoped would make the anæsthetic so preferable to ether and chloroform. Again, the inconvenience of carrying about large supplies of nitrous oxide such as are necessary for long operations restricts the use of this agent. For short operations, in which absolute quiet and flaccidity are not necessary to success, such as opening abscesses, removal of small tumours, amputation of finger, etc., and for painful dressings, gas and oxygen and gas and air are often most suitable. For a person, too, who has on previous occasions suffered severely from after-effects of ether or chloroform, and has again to undergo operation, prolonged administration of nitrous oxide may fairly be tried. It must be borne in mind, however, in such a case, that with some subjects successful anæsthesia is impossible by means of nitrous oxide. With a very robust, alcoholic, or highly excitable subject, success would be most unlikely, and it would be wiser to resort straight away to the more powerful anæsthetics, if at all a prolonged anæsthesia is desired. In extremely rare instances no anæsthesia at all can be obtained by nitrous oxide, violent convulsions coming on before the patient is anæsthetized.

The objection to using nitrous oxide pure is that when its full anæsthetic effect is obtained this is accompanied by—

1. Spasmodic obstruction in the upper air-passages ;
2. Cyanosis.
3. Jactitation—*i.e.*, clonic muscular contractions ; and sometimes
4. Opisthotonos—tonic muscular contraction.

These results are due not so much to nitrous oxide *per se* as to the paucity of oxygen that is necessarily associated with the pure administration. They are accordingly almost entirely removed by a proper combination with nitrous oxide of air or of oxygen. For quite short dental operations the pure gas may be used, and since in inexperienced hands the best results are difficult to obtain with the combination of air or of oxygen, this method will be first described. It is to be confined to cases in which an available anæsthesia of not more than about half a minute is desired. The method of obtaining a longer anæsthesia by re-applying the apparatus a second time before consciousness has fully returned, and repeating the administration of nitrous oxide, is not recommended, as it is more productive of unpleasant after-effects than the other devices, shortly to be described, for securing a long anæsthesia. The length of time that anæsthesia lasts depends partly on the length of time for which the gas can be administered before the face-piece is removed, and partly upon the freedom with which breathing is performed directly after. The more free the breathing the quicker the recovery. Similarly, if the operation interferes with breathing, as by pressing upon the tongue, recovery is delayed and anæsthesia longer.

Apparatus and Administration

Two side-valve cylinders (Fig. 2), each yielding 25 gallons of nitrous oxide, with stand, double union, and foot-key. For hospital work cylinders of 50 or 100 gallons are generally used. These are connected by an indiarubber tube with an indiarubber bag, capable of holding 2 gallons of the gas. This bag is connected with the face-piece by Hewitt's valved stop-cock. The

cylinders are not to be used alternately, but the foot-key is to be kept upon one, and this one used till it is

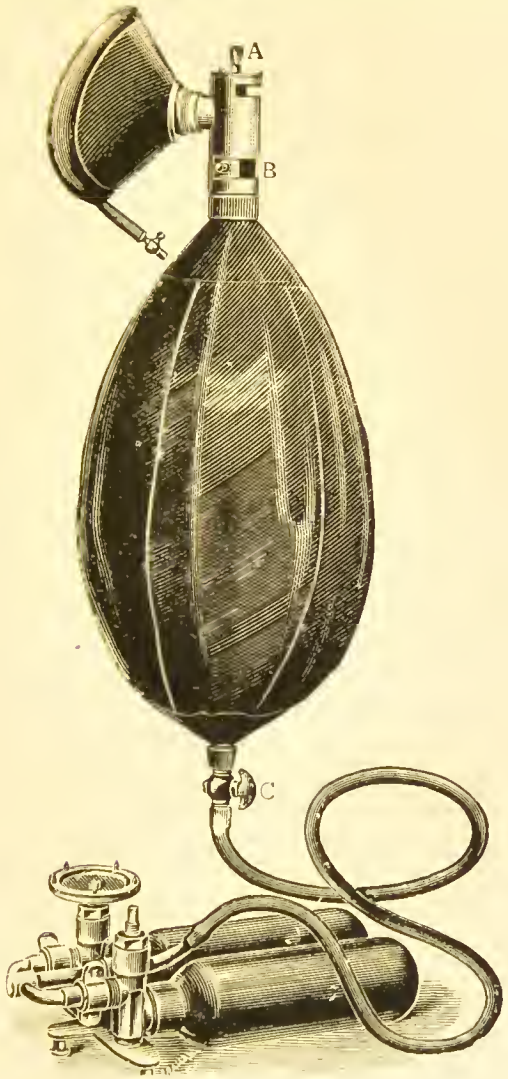

FIG. 2.

exhausted. The other is then put into use, and the empty one replaced by a full cylinder. In this way the

risk of having both cylinders empty at the same time is avoided. The full cylinder should be tested by weight before being used, to see that the weight stated on the label is correct. The sound which a full cylinder gives when struck with a metal instrument as compared with that from an empty cylinder treated in the same way is another useful guide. Before approaching the patient, test the apparatus by turning on a little gas and pressing it out of the bag with 'B' on and 'A' open. The foot-key is turned by pressing upon it with one foot, and then rotating the knee from left to right. The requisite amount of pressure is soon learned by experience. It is important to turn off thoroughly when as much gas as is desired has been admitted to the bag. Then turn off B and fill the bag about two-thirds full. Place the cylinder in such a position that the foot-key will be easily used when the face-piece is applied. Next see that the head is properly placed, not over-extended, nor with the chin bent towards the chest, but in a natural line with the shoulders. Feel the pulse, inspect the open mouth, and insert the prop if one is to be used. The bladder should always be emptied shortly before nitrous oxide is taken. All clothing round the neck, chest, and waist is to be loose.

Gently apply the face-piece, assuring yourself that it fits accurately. This is best told by the sound made as the patient breathes air in and out through the closed valves.

If there is a moustache or beard, the hair may be moistened with water where it comes into contact with the face-piece.

Hold the face-piece upon the face with the left hand, keeping the little finger below the patient's chin.

Use two fingers of the right hand to keep the cushion

of the face-piece pressed securely against the root of the nose, insuring no leakage of air there.

Ask the patient to draw his breath in and out of the mouth.

Being certain that he is breathing freely, turn on B with your right hand.

Turn the foot-key so that gas streams freely into the bag without making any loud noise.

The patient is now breathing gas in freely, and expiring through A into the outer air. The gas-bag is kept nearly full by continuous working of the foot-key.

After about half a minute consciousness disappears, the breathing is deeper and quicker than natural, the face gradually gets dusky, and the pupils dilate. Conjunctival sensitiveness remains. During the first few breaths there is often rapid, almost fibrillary twitching of the eyelids.

Respiration continues to be regular and more rapid than natural breathing, except, perhaps, for a swallowing movement, till about one minute has elapsed.

Anæsthesia is then, after about thirty breaths, generally present, and is most obviously shown by the jerky guttural character of the breathing. A characteristic throat sound is heard, which is probably due to irregular elevation of the larynx, and which indicates obstruction to free entry of air into the larynx. As soon as this sound is heard, or even just before, when anæsthesia is thought to be almost at its height, 'A' may be closed and rebreathing to and from the bag permitted for a few breaths. A longer anæsthesia is obtained in this way.

Muscular twitching is present, if not jactitation, or retraction of head, or opisthotonos. The conjunctival reflex is usually absent.

The pupil is widely dilated, the eye generally partly

uncovered, and the colour of face and lips a dusky blue. The duskiness is the more pronounced the more fully-coloured is the patient's natural complexion. The time taken to produce these symptoms of course varies greatly with the nature of the patient. A child or an anæmic woman may be unconscious after a few seconds, a robust man may take two or three minutes to reach anæsthesia.

When to Stop the Administration

If the operation is a very short one—*e.g.*, easy removal of one tooth—remove the face-piece as soon as the 'stertor' is heard. At this moment, too, operations not involving removal of the face-piece may be begun. In other cases it is better to keep it on for three or four further breaths. The amount of clonic activity must also be taken into account, and this, affecting respiratory muscles, may necessitate removal of the face-piece before the characteristic sound is heard at all. Similarly, clonic retraction of the head or marked opisthotonos may necessitate removal of the face-piece before the stertor has been heard.

The conjunctival reflex is not a certain sign—it sometimes persists during the anæsthesia, and the corneal reflex most often does so. Usually, however, the conjunctival reflex is dulled or abolished, and the arms and legs are generally flaccid, falling limply if raised and then released.

In some cases, when deep anæsthesia is established before 'stertor' appears, respiration becomes feeble, or expiration prolonged, or breathing actually stops. The administration must, of course, then cease. Similarly, a widely dilated pupil with insensitive conjunctiva must cause the removal of the face-piece, irrespective of other symptoms. The rapidity of the pulse is increased during

nitrous oxide anæsthesia. It becomes fuller and slower with recovery.

1. *Especial care is to be taken* to hold the face-piece firmly to the face, permitting no leakage.

2. To give enough of the gas, not removing the face-piece till the throat sound characteristic of anæsthesia from pure nitrous oxide is heard, or till muscular twitching occurs.

Usually the inexperienced administrator gives too little gas. He should remember that asphyxia is practically the only danger to be feared, and will not arise without marked cyanosis or pallor, or convulsive muscular contractions, or the respiratory or pupil signs above alluded to, which even the inexperienced cannot fail to observe.

Nitrous Oxide and Air

The admission of air in indefinite quantities is easily effected by the same apparatus that has just been described for giving pure nitrous oxide. Air cannot be admitted absolutely coincidently with the gas, but by use of 'B' a breath of air can be let in whenever desired, nitrous oxide being for the moment shut off.

Administration.—The administration is to be conducted exactly as for nitrous oxide only, till about twelve respirations have passed. Then turn 'B' off, allowing one inspiration and one expiration before again closing the handle.

After five more breaths, repeat the air admission for one breath, and continue to do so every five breaths until anæsthesia is fully established.

In this way the peculiar obstructive sound elicited by nitrous oxide alone, the jactitation, opisthotonos, and pronounced cyanosis of the former method are present in only a modified form.

Operation is to be begun when respiration becomes irregular, or slight muscular twitchings, or absent conjunctival reflex and slight duskiness of features are present.

Generally there is muscular relaxation.

In oral and nasal cases the face-piece is now to be removed. In other cases the administration may be continued as long as is desired. The longer it lasts, the more frequently will a breath of air be required, the anæsthetist being guided as to its admission mainly by the patient's colour and the manner of his respiration. Different types of patient require very different amounts of air and of nitrous oxide. Muscular, high-coloured, and alcoholic individuals must be given large supplies of nitrous oxide and comparatively little air, while exactly the reverse holds good for the wasted and anæmic patients or for children. This method of using nitrous oxide with air is, perhaps, the most generally applicable use of the gas for all dental and nasal operations that can be done within one minute, and for operations elsewhere that take under ten minutes and do not require absolute immobility and relaxation. The anæsthesia is not so deep, so quiet, nor accompanied by so favourable a condition of the patient as is obtained by use of gas and oxygen. On the other hand, the administration occupies less time, is more easily learned, and the apparatus is simpler.

Nitrous Oxide and Oxygen

To combine nitrous oxide with definite proportions of oxygen is a more scientific method of overcoming the limitations to the use of the former gas than that last described. There are, however, these drawbacks:

1. The necessary apparatus is more complicated, and more liable, therefore, to disorder.

2. Longer time is required to produce the deepest available anæsthesia.

3. Much practice is required to obtain the best results, and it is not easy to be certain when anæsthesia is present.

The advantages obtained are :

1. Quiet respiration, almost entirely free from stertor and obstruction.

2. Absence of clonic muscular contraction and of cyanosis.

3. Longer available anæsthesia.

The sensations of the patient and after-effects are about the same as with nitrous oxide and air. With both methods, owing to the fact that longer administration is possible, there is rather greater tendency to emotional disturbance and to nausea or headache than is the case after nitrous oxide only. On the other hand, unpleasant sensations during the induction of anæsthesia are more common when air or oxygen are excluded.

In skilled hands, then, gas and oxygen should be chosen for all ordinary dental operations, and for other operations lasting about ten minutes in which absolute immobility and relaxation are not essential. For similar operations of even longer duration the method may be employed subject to the conditions already mentioned. For long dental operations it is best not to rely upon nitrous oxide.

Apparatus and Administration. — The best apparatus is that perfected by Dr. Fred. Hewitt, and fully illustrated in his work.

Two cylinders of nitrous oxide, coupled with one of oxygen, are required. Fifty-gallon cylinders are generally used. The main points to be observed are :

Fit the face-piece very accurately to the face, turn on oxygen and nitrous oxide so that each bag is about one-third full. When breathing is quite regularly and fully performed, turn the indicator so that nitrous oxide with 2 per cent. oxygen is at once admitted. Keep working the foot-key of the gas-cylinder so that the tension of the oxygen and nitrous oxide bags is equal throughout.

Increase the percentage of oxygen so that cyanosis to any marked degree is not permitted, and clonos does not arise.

The more robust the patient, the less the proportion of oxygen required to secure the best anæsthesia. Muscular twitching or clonic movements are indications for increasing, excitement, or a condition approaching apnœa, for diminishing, the percentage of oxygen.

The signs of anæsthesia are :

Regular softly-snoring respiration.
Absent conjunctival reflex—medium-sized pupils.
Flaccid muscles—the arms drop limply if raised.
Fixed or slightly oscillating eyeballs.

Gas and oxygen is particularly well suited to children, middle-aged and elderly thin women, anæmic persons, the subjects of heart disease with broken compensation ; it is not advisable for very muscular, alcoholic, very fat, and excitable patients.

When employing gas and oxygen for any but the shortest operations the anæsthetist should always have ready apparatus for administration of the more powerful anæsthetics, in case the gas and oxygen prove insufficient.

Nasal Administration of Nitrous Oxide

For dental operations requiring a longer anæsthesia than can be secured by the above methods, nitrous

oxide may be used throughout ; the administration must be continued through the nose after operation has begun.

The anæsthesia which can be thus kept up is similar to that obtained by the use of pure nitrous oxide. That is to say, it is accompanied by duskiness of the features, and by clonic or twitching muscular movements. It has, however, this advantage over administration of ether or ethyl chloride, the usual alternatives, that after-effects are scarcely more than from the ordinary administration of nitrous oxide in dental surgery.

The method is thus particularly useful in hospital practice, when it is of advantage to be able to send patients away within a few minutes of operation.

Two forms of apparatus are available. In one (Paterson) a metal nose-piece with rubber air-pad is fitted over the nose, a prop inserted in the mouth, and nitrous oxide supplied to the nose-piece from the beginning. If there is difficulty in establishing nasal breathing, an independent celluloid mouth-piece with an expiratory valve is placed over the mouth. In the other (Harvey-Hilliard) anæsthesia is induced by giving nitrous oxide in the ordinary way, and when anæsthesia is fully established and the operation begun, a small silk catheter is passed through one nostril to the back of the pharynx. This catheter is connected up with the gas-cylinders, and nitrous oxide is allowed to stream through it into the naso-pharynx at considerable pressure. The only advantage of the catheter method is that in operations upon the upper jaw the anæsthetist is less in the way of the operator than is the case when the nose-piece is in use.

CHAPTER III

ETHER

For reasons given on p. 70 ether is recommended as the routine anæsthetic to be given to healthy persons of all ages when nitrous oxide does not suffice.

Although ether can be given more rapidly and with less unpleasantness to the patient if preceded by nitrous oxide, this method requires greater skill and more apparatus. There are objections also to the routine use of ethyl chloride before ether except in expert hands. The student, therefore, is advised to familiarize himself thoroughly with the administration of ether alone as now to be described. When his experience of giving anæsthetics in practice becomes occasional only, or when, as in country practice, the portability of apparatus is an important consideration, 'gas and ether' will not be a suitable method for him to employ. When these considerations do not apply, as, *e.g.*, in the case of those who frequently give anæsthetics, and can easily obtain and carry their supplies of nitrous oxide, gas and ether replaces ether as the routine anæsthetic, and the way to give it will be next dealt with. We are now concerned with the administration of ether only, as it may be given to persons of four years of age and upwards. One method, which I consider generally the best, will be described in detail. Other ways in which ether may be

given will then be briefly alluded to ; this plan is followed, also, in the case of the other anæsthetics.

Apparatus, Etc.

Whenever a general anæsthetic is to be given there should be at hand, besides the anæsthetic and the

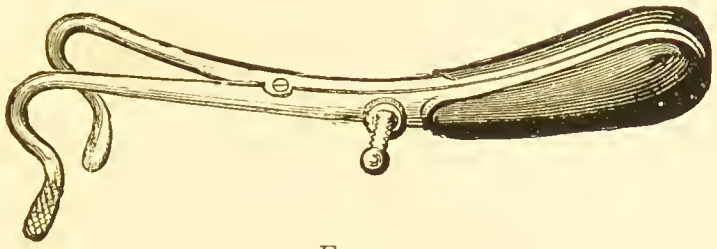

FIG. 3.

apparatus for administering it, the following articles which may become necessary for overcoming inconveniences or dangers :

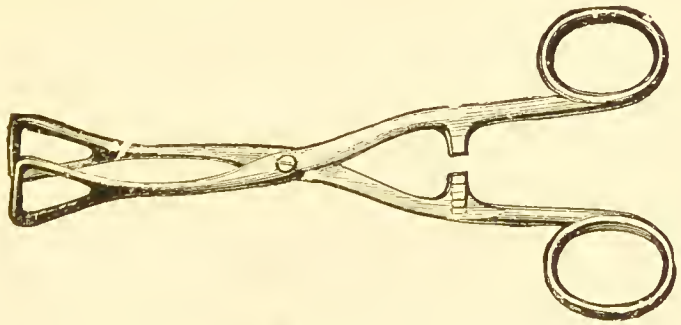

FIG. 4.

1. Mason's gag (Fig. 3).

2. Tongue forceps—the blades to be rounded and capable of gripping tightly without cutting (Fig. 4).

3. Wooden wedge (Fig. 5).

4. Mouth-prop, with a foot of stout silk connecting another size of prop.

5. Small sponge for use in the mouth.

6. Case containing scalpel and two sizes of tracheotomy-tube.

7. Hypodermic syringe and bottle of liq. strychninæ, capsules of amyl nitrite, capsules of hemesin, and transfusion apparatus (Figs. 6 and 7).

Fig. 5.

For the present purpose there must also be—

1. Clover's portable regulating ether inhaler.

2. Large and medium-sized face-piece.

3. Measure for filling inhaler, to hold at least 1½ ounces.

4. One pint of ether.

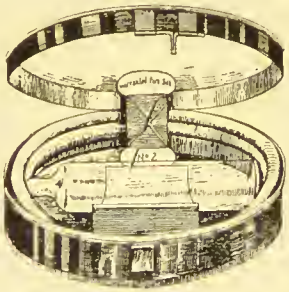

Fig. 6.—Mummery's Transfusion Apparatus, in Case.

Clover's Portable Regulating Ether Inhaler.—To understand the way in which ether is given by this instrument the student is recommended to examine an inhaler carefully, and study the diagrams given in larger works (Hewitt's 'Anæsthetics,' p. 376 *et seq.*). The essential features are :

1. A metal reservoir containing ether.

2. This is pierced by, and communicates with openings in, a central shaft.

3. The shaft is fixed on to the face-piece.

4. A small bag fits on to the top of the metal reservoir.

5. The ether reservoir is surrounded by a cylindrical cap of metal, the space between the two being nearly filled with water. This water-chamber prevents the apparatus from getting too cold.

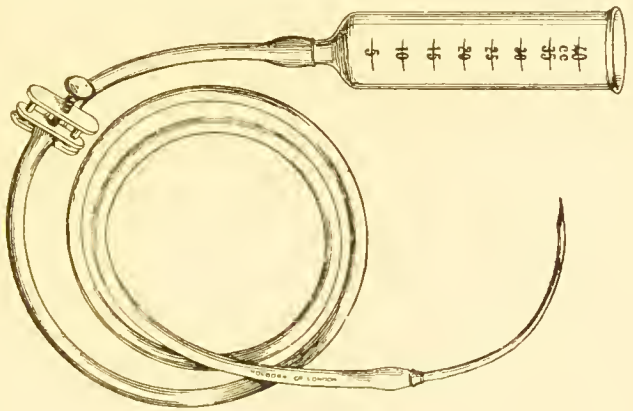

FIG. 7.

6. An indicator fixed to the shaft near the face-piece points to marks '0,' '1,' '2,' '3,' 'F,' on the outside of the ether reservoir. When the instrument is charged with ether, and the reservoir caused to revolve upon the shaft, ether vapour reaches the face-piece in various strengths according to the position of the reservoir. When the indicator points to '0,' no ether vapour reaches the face-piece; when it is at 'F,' a breath drawn down the shaft traverses the ether reservoir, and reaches the face-piece saturated with ether vapour. In the intermediate positions from '0' to 'F' the air

breathed down the shaft is progressively more and more mixed with ether vapour, by coming more and more widely into communication with the ether reservoir through the openings in the shaft.

7. The ether reservoir is filled through an opening into which is fitted an ordinary cork, or a stopper containing a small glass bulb. By tilting the reservoir, ether runs into the stopper, and can be seen through the glass. The anæsthetist can thus inform himself when refilling of the reservoir is necessary in the course of an administration. Another rougher guide is afforded by the comparative coolness produced in the lower part of the inhaler as long as ether is evaporating within it.

Linen and paper bags are sometimes used on the score of extra cleanliness. Those of indiarubber, however, are not spoilt by thorough cleaning after each use.

Administration

Warm the inhaler by placing it in hot water or before the fire for a minute or two.

Fit on the face-piece which appears best suited to the patient.

Keeping the indicator at 'o,' slowly pour in 2 ounces of ether. Draw a breath in and out through the face-piece, to be sure there is no ether vapour there or in the shaft of the inhaler.

The patient lies upon his back with the head turned to one side. Allow the head and shoulders to be raised to the extent found comfortable.

Having made a brief examination (p. 74), and inspected the mouth and pharynx, stand behind the patient and gently adapt the face-piece. The bridge of the nose, the narrow upper end of the face-piece, and the indicator at 'o' are in a line.

Grasp the face-piece with the left hand, the little finger of which rests behind the angle of the jaw which is uppermost. Press the face-piece against the face in such a way that it is firmly against the root of the nose, and so close all round that no air can enter between it and the face. Where there is a moustache or beard particular care is needed to avoid leakage of air. Much practice is needed before the face-piece can be held with just the right amount of pressure. The chin must not be depressed by it, and the pressure must not cause discomfort. Hold the ether chamber lightly with the right hand.

Tell the patient to breathe in and out through the mouth.

Fit the bag on to the top of the inhaler during an expiration. Exert a little pressure during expirations, and raise the face-piece during the first two inspirations after applying the bag. In this way the bag is distended, and the patient can breathe comfortably to and fro.

Breathing being regular and full, very slowly rotate the reservoir with the right hand. Take at least one minute to reach '1' and another to reach '2.' The secret of inducing anæsthesia quietly is to progress slowly enough in this early part, avoiding cough and irritation by not giving too strong a vapour while consciousness is still keen.

The breathing is now quicker and deeper than at first, and the face rather flushed. The pupil is somewhat dilated; the pulse is more rapid than at the start. Steadily continue rotating the reservoir till, after about three or four minutes, 'F' is reached. There is then vigorous stertorous breathing and some duskiness of the face. The pupil settles down to about medium size;

the pulse is little faster and fuller than normal. A breath of air is to be given by lifting off the apparatus for a moment. Quickly wipe mucus away from the mouth and interior of the face-piece.

Tuck 2 inches of the corner of a towel inside the dependent cheek and re-apply the apparatus. The towel serves to conduct away some of the mucus, which is otherwise swallowed and adds to the after-sickness.

Anæsthesia is now established, and is shown by—

1. Insensitive conjunctiva.
2. Stertorous breathing.
3. Flaccid muscles (the arm, if raised, falls limply to the side).
4. Medium-sized pupils, only faintly reacting to light.

A little later the pupil reflex generally entirely disappears, and the corneal reflex is also absent if this full dosage of ether is continued.

Keep the indicator at 'F' till the skin incision has been made, then turn back to '2.' From now till the end of the operation it is the anæsthetist's object to keep the patient a good colour, with quiet, regular respiration and pulse, and freedom from all movement, with a minimum expenditure of ether. The rate of respiration and of pulse when ether anæsthesia is established is usually more rapid than the natural rate. The effect of ether in this respect varies much with different individuals. Usually the rate of respiration is more increased than that of the pulse. The effect is more noticeable in the young and vigorous, and during the early stages of an administration. The less anæsthetic used compatible with perfect anæsthesia the better, for

recovery is quicker and after-effects are less troublesome than if the patient is unnecessarily saturated with the drug. There is great difference between the amount required by different patients. In most cases, if the indicator is at '2' after the skin incision, no stronger dose is required, and in long operations it may be brought to '1,' or even '½,' for the greater part of the time. Once anæsthesia is completely induced comparatively little anæsthetic is needed to maintain it. After about fifteen minutes the original 2 ounces of ether will be used up. Remove the apparatus from the face, take out the stopper, and pour in 1 ounce of ether. Turn back to '0' before re-applying, and then with each breath advance the reservoir till '2' is again reached after eight breaths. This ounce of ether will last about seven minutes, when the refilling must again take place. To keep the patient a good colour let him have one breath of air to every four of ether, the apparatus being lifted from the face for the purpose.

How to know that the Proper Degree of Anæsthesia is being maintained

The student must keep a constant watch upon the respiration and upon the patient's colour, the best guide to which is the lobe of the ear. He must feel the pulse at the wrist or temple every few minutes, and raise the eyelid to observe the pupil equally often. It is generally best to maintain a depth of anæsthesia during which the pupil and conjunctival reflexes are abolished, the cornea being just responsive. In many cases, however, under ether the proper anæsthesia is accompanied by faint reaction of the pupil to light.

Light anæsthesia is shown by—

1. Small pupil, reacting to light.
2. Returning conjunctival reflex.
3. Rigidity of muscles.
4. Swallowing movements.
5. Irregularity of respiration, with tendency to expiratory, almost phonated, sounds, coughing.

These symptoms should lead to an increased dose, or they will be followed by—

6. Retching or vomiting.
7. Movements, reflex and semi-voluntary.

Proper surgical anæsthesia lies between the condition in which the above symptoms are present, and

Too deep degree of anæsthesia, on the other hand, as shown by—

1. Dilated pupils, not reacting to light.
2. Pallor or blueness of face.
3. Profuse sweating.
4. Feebleness of respiratory movements and of pulse; the pulse becomes irregular as well as feeble.
5. Upturned eyeballs, with partially open lids.

Holding of the Breath.—This arises in two ways. The first is a voluntary act on the part of a nervous patient, or when too strong a vapour is offered before sensibility is dulled. The second kind is reflex, and occurs in connection with swallowing movements or with retching. The first variety is distinguished by occurring almost directly the anæsthetic is begun. It is overcome by patience, and by a few quiet directions, such as a request to blow out firmly into the bag, or a child may be asked to start counting. No attempt

must be made to 'rush' the anæsthetic. This leads the patient to refrain from breathing to the longest possible extent, or else to struggle violently. The second variety, which occurs later, is met by pushing the anæsthetic.

Rapid Breathing.—Nervous subjects, particularly women and youths, often start breathing in a very rapid, shallow manner directly the apparatus is applied. Such an effort is soon followed by a long rest from breathing, and persons who behave in this manner generally delay the process of induction. It is best simply to ask them to breathe rather more slowly, at the same time turning the inhaler very gingerly.

A *sigh* often recurs, sometimes at perfectly regular intervals. It has no significance if there is proper absence of cyanosis.

The *eyeballs* may roll irregularly or with a movement almost of nystagmus. They are generally still during deep anæsthesia. In very deep narcosis or with patients who are feeble they may be rolled up and the upper eyelid not quite closed, a rim of sclerotic showing between the lids.

Clonic spasm, particularly of the lower limbs, sometimes arises during ether anæsthesia for no apparent reason. This is sometimes due to the position in which the patient is placed, and is not uncommon when the crutch and lithotomy position are employed. Similarly, a *fine tremor* is sometimes seen, particularly during the induction period. Ankle clonos can usually be elicited in light degrees of ether anæsthesia. The patellar reflex is generally abolished.

Irregular movements of the arms or hands towards the trunk sometimes occur. These and many small muscular movements, as well as convulsive muscular

contractions, are provoked if a partially asphyxial state is allowed through insufficient supply of air.

An *erythematous rash* ('ether rash') on the neck, chest, and arms often appears during the first few minutes of etherization, and passes away within a quarter of an hour.

Excitement and violent purposive movements may arise during the induction of anæsthesia. They occur particularly in alcoholic, excitable persons and those unaccustomed to self-control, and are most likely to arise when the first stage of disordered consciousness is passing into the second stage, during which reflex excitability is still present. In case such inconvenience should arise, never start to give ether without somebody standing by the patient's side to exert control if desired. The anæsthetist will be fully occupied in keeping the apparatus firmly on the face, and controlling the head and chest. The patient's arms should always be by his side, and covered with the blanket, etc., when the administration is begun. When 'struggling' is present do not be in too great a hurry to give air, even though there is some cyanosis, until consciousness is fully abolished. The inexperienced anæsthetist is liable to think it necessary to give a breath of air to quell excitement. Such an act prolongs the disturbance, which ceases if the apparatus is kept firmly applied, and anæsthesia thus induced.

If *coughing* occur early in the administration, the reservoir is to be turned back to '0,' and advanced more slowly than before; if the '2' is already reached, push on rather faster, and the coughing will cease with the advent of anæsthesia.

Tonic spasm, local or general, occurs often during induction, sometimes in the course of ether anæsthesia.

In muscular subjects, particularly dark, muscular, thick-necked men, *spasmodic closing of the jaws* occurs during induction, and, combined as it often is with swelling of the tongue and fauces, may cause much embarrassment to respiration. When such a difficulty can be anticipated, and in cases of nasal obstruction, insert a small prop between the teeth before beginning to give ether (p. 89). If the spasm is severe, and this precaution has not been taken, it may be necessary to open the mouth with a gag before proceeding with the administration, and to give the ether freely, but with free air-supply through the top of the inhaler.

Secretion of mucus and saliva takes place freely during the early stages of ether-taking, and to some extent throughout. The amount secreted varies greatly with different individuals. A noisy gurgling sound with respiration may be caused by mucus in the upper air-passages and the trachea.

When to stop the Administration

In ordinary cases remove the apparatus as soon as the last stitch is inserted. When the surgeon begins to insert the stitches, turn back to '$\frac{1}{2}$' if more ether than this is being given. In abdominal cases keep the apparatus on till the dressing is applied, for in these it is often undesirable that coughing or retching should begin before pressure can conveniently be applied over the wound. Persons who require a great deal of ether are those who recover most quickly after it. Such are the big muscular men and those accustomed to alcoholic drink. With them it may be advisable to continue the administration longer than in other cases, and there are, of course, other exceptions to the above general rule,

which can only be learned by experience. (For removal and after-care of patient, see Chap. XI.)

Cleansing the Apparatus

Wash the face-piece with soap and water, swab it over inside with 1 in 40 carbolic solution, and thoroughly dry it. With the inhaler at '2,' remove the stopper and pour out any ether still remaining. Clean the inhaler and bag out separately with hot water. Boil the gag, prop, and tongue-forceps if these have been used.

Remove the reservoir from the central tube, carefully dry this, and grease it with a little vaseline.

Hewitt's Modified Clover's Inhaler

The above description applies, generally speaking, but this inhaler has a wider bore, and can be filled without removal from the face. Also the reservoir is stationary, and the amount of ether given is regulated by a moving handle, which causes the central shaft to revolve.

An essential point in the administration of ether as just described is considerable *limitation of air-supply*, particularly during induction of anæsthesia.

Other Methods and Apparatus

The same principle is acted upon in using *Ormsby's inhaler*, with which instrument, however, the dose of ether cannot be graduated to the same extent as with Clover's apparatus. One ounce of ether is poured upon the sponge of the inhaler, which is previously wrung out in warm water, and the face-piece is gradually placed near, and finally on, the face. The instrument is good for maintaining ether anæsthesia, not so good for in-

ducing it. It is particularly useful in cases where any strong dosage of ether is necessary, and where obstructive respiratory difficulty arises. There is greater freedom of respiration from Ormsby's inhaler than through the comparatively narrow shaft of Clover's apparatus.

Semi-Open Method

Ether may be given from *Rendle's mask* or from a *cone*, and with both these instruments a free supply of air is provided through the top of the apparatus. Either implement is very useful when it is desired to continue an administration with ether, to admit plenty of air, and to offer easier conditions of respiration than those of a closed inhaler, as is the case sometimes with feeble patients. Certain patients, too, in whom chloroform evokes spasm are well anæsthetized by ether from a semi-open inhaler. A felt cone is the best instrument to use for giving ether to infants, as is advantageously done for short operations. A couple of drachms of ether are to be poured on to the sponge of the cone, which is previously wrung out with warm water. The cone is held at first at such a distance from the face that coughing or holding of the breath is not excited by the ether vapour. Gradually the cone is brought nearer and then on to the face, just as in the case of Ormsby's inhaler. Ether is to be added a drachm at a time at frequent intervals throughout the administration.

The induction of ether anæsthesia by a semi-open method is always unpleasant to the patient, a lengthy process, and can seldom be called for. Still less is ether to be given *openly—e.g.*, from a drop-bottle on a Skinner's mask. A maximum amount of anæsthetic and a minimum amount of anæsthesia attend such a method. Ether is

sometimes given from one bottle of a two-bottled Junker's inhaler when, chloroform being given continuously from the other, it is desired to add a little of the former drug from time to time (Tyrrell). Similarly, it is often a good plan in the course of a long operation, during which chloroform is being taken from a Skinner's mask by a feeble subject, to pour on the mask from time to time ½ drachm of ether for the sake of its stimulating effect.

Ether preceded by Nitrous Oxide—'Gas and Ether'

By giving ether preceded by, and at first combined with, nitrous oxide, two advantages are gained:

1. More rapid induction of unconsciousness.
2. No unpleasantness during induction from the taste or irritation of ether vapour.

The nitrous oxide is to be regarded simply as an auxiliary, by means of which consciousness is rapidly sufficiently dulled to allow the introduction of strong ether vapour more quickly than would otherwise be possible. There is no advantage in obtaining the full effects of the nitrous oxide, and these are, in fact, to be avoided. It is the anæsthetist's aim to introduce ether vapour while nitrous oxide anæsthesia renders this unnoticeable, and to secure ether anæsthesia by the time nitrous oxide has left the patient. This object is best secured by starting the administration with nitrous oxide alone, gradually adding ether, and then giving no more nitrous oxide while ether is further added.

Apparatus and Administration

Besides the articles enumerated (p. 27), there are required:

1. Two cylinders of nitrous oxide with stand and foot-key.

2. The indiarubber tube from the cylinders is fitted at

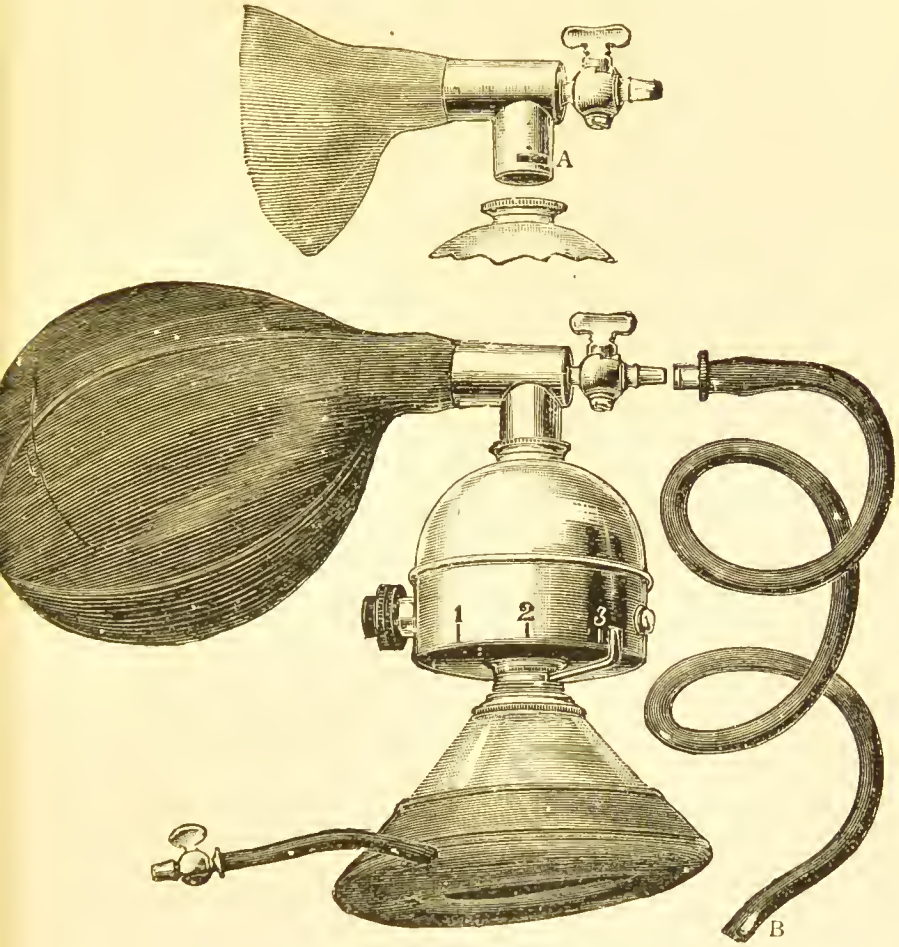

FIG. 8.

A, Slot for air admission ; B, tube for attachment to gas-cylinders.

the other end over a small metal tube, which fits on to a tap coming from the angle-piece of the bag of the inhaler. When the tap is 'on,' gas can be sent from the

cylinder to the bag of the inhaler. When there is no further use for the nitrous oxide, the tube with its metal end is simply pulled off the tap. The same bag thus suffices for continuing the administration (see Fig. 8).

The preliminary steps are the same as in the case of ether only, but, in addition, test the action of the foot-key. The cylinders are to be placed where they are invisible to the patient, and the key so worked as to make the least possible noise.

When the face-piece is firmly and comfortably adjusted—

1. Turn on gas till the bag is distended, and fit it on just after an expiration, then turning the key so that only enough N_2O is supplied to keep the bag distended during the next inspirations.

2. Respiration being fully performed, allow three breaths to be drawn, the face-piece being raised during each corresponding expiration, and then—

3. Turn on ether as described (p. 31). The patient now breathes a mixture of nitrous oxide and ether, his first three breaths having been of nitrous oxide only.

4. When '2' is reached there is unconsciousness, and the mixture of vapours is being freely breathed. Respiration is deeper and more rapid than at first, and there is some congestion of the face. Lift off the bag and rapidly advance to '3,' and then to 'F.' Air is drawn freely in through the open top of the inhaler over the ether in the reservoir, and expired again through the top. The bag is emptied of its mixture of vapours, and reapplied during an expiration.

5. If there is any coughing or excitement, due to the effects of nitrous oxide having passed off and those of ether being not yet fully established, let in a little more gas, turn back to '2,' or to '1,' till the additional

nitrous oxide quiets the excitement. Then rapidly add ether again, empty the bag, and reapply it as before.

6. Ether anæsthesia being fully established, remove the tube from where it is fitted on to the angle-piece of the bag of the inhaler, turn the tap 'off,' and arrange matters as with ether only (p. 32).

It is sometimes an advantage to have a bag full of nitrous oxide, without any gas-cylinders in the neigh-

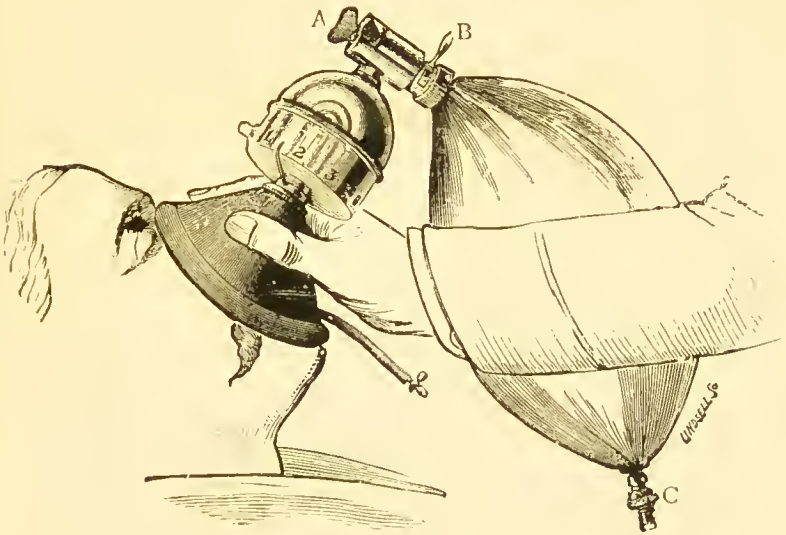

FIG. 9.

bourhood of the patient. In such a case the bag must be used, with Hewitt's valved stop-cock, that was described on p. 17, for the administration of nitrous oxide, the taps 'C' and 'B' being both turned off when the bag is filled, the tube to the cylinders being removed, and 'B' being turned on when the administration is begun. If there is any doubt of the quantity of nitrous oxide in the bag being sufficient, 'A' must also be closed, rebreathing being allowed. When Hewitt's apparatus

is employed for giving gas and ether, the large bag with stop-cock is removed when ether anæsthesia is established, and its place taken by the small bag of the Clover's inhaler. In the simpler method first described only one bag is required throughout.

Another method is to give nitrous oxide and ether in succession, but separately. Nitrous oxide is given till its effects are fully established ; the apparatus is then removed, and a fully-charged Ormsby's inhaler substituted, and at once applied closely to the face. This method has the disadvantage of not being so widely applicable as that described. A certain, fairly large, number of patients will give rise to trouble from spasm and cyanosis if the full effects of nitrous oxide are produced in them and etherization then at once proceeded with.

By the method first described the vast majority of persons can be brought rapidly and with remarkable absence of discomfort or excitement under the full influence of ether. It must be borne in mind, however, that 'gas and ether,' though so readily applicable, is not the best anæsthetic in all cases. The instances when it is best avoided are discussed in the chapter on the choice of anæsthetics. When trouble arises in the induction of anæsthesia by this method it is more often due to the too free than to the too sparing use of the nitrous oxide. Too early admission of air is another source of difficulty, excitement, if it has arisen, being thereby unduly prolonged.

Ether preceded by Ethyl Chloride

In some cases, particularly those of strong alcoholic men with fat chins, where 'gas and ether' is not suitable from the congestion caused, and where ether alone is

apt to be accompanied by a prolonged excitement stage, the use of ethyl chloride as a preliminary has advantages. It is also applicable in the case of the very nervous and of children, where rapid induction of unconsciousness is to be desired.

The simplicity of the method of the apparatus, as

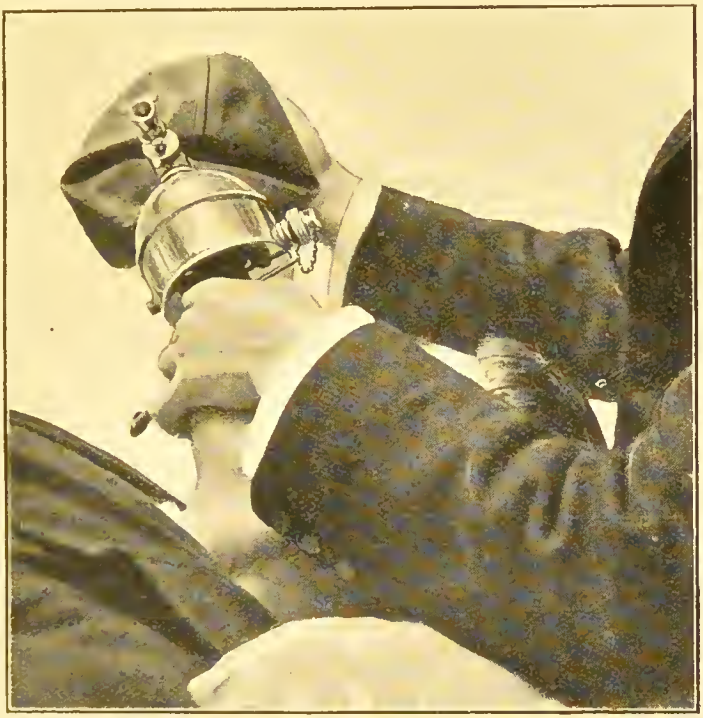

FIG. 10.

compared with that for 'gas and ether,' renders this combination a most convenient one for use in country practice. The induction of anæsthesia is often accompanied by momentary violent movement, generally of the arms, sometimes of lower limbs and trunk. It is also sometimes associated with spasm of muscles, particularly of the jaw, for which reason it is best, as a

routine practice, to get the patient to bite upon a small prop. There is remarkable absence of cyanosis, and the face-piece should generally not be lifted till a stertorous breath has been heard. The following are the steps I recommend in securing anæsthesia by ethyl chloride and ether :

1. The inhaler being warmed and charged with 2 ounces of ether, and the patient's head being turned to the right with small prop between the right molars, spray 4 c.c. directly into the bag, which is dependent (see Fig. 13). Then turn off tap A.

2. Instruct the patient to breathe quite quietly ; no long-drawn breaths are desirable, as in the case of nitrous oxide.

3. Apply the face-piece, and during the first three breaths raise the bag till it is in a line with the inhaler.

4. Turn on ether to $\frac{1}{4}$.

5. Examine the eye, and if conjunctival reflex is gone and the globe is fixed, turn on to $\frac{1}{2}$.

6. Stertor will almost invariably be now present. Give a breath of air, reapply the inhaler so as to catch an expiration, and continue as though ether had been given alone.

The above applies to healthy adults. In the case of a child or a feeble woman not more than 2 c.c. of ethyl chloride should be used, and the ether not so rapidly advanced.

Especial care is to be taken—

1. To secure quiet breathing at first.

2. To have very complete adaptation of the face-piece to the face.

CHAPTER IV

CHLOROFORM

THE cases for which chloroform is to be chosen are discussed in Chapter VI. The student is advised to use it only as there indicated, not to regard chloroform as a routine anæsthetic; to make a practice of never *inducing* anæsthesia with chloroform without special reason, and never to give it to a patient in any but a recumbent position. Naturally, the expert may see good reason for disregarding any or all of these principles.

Apparatus and Administration

No closed apparatus should be used for the administration of chloroform, and a closely-fitting face-piece is undesirable.

By whatever method the drug is administered, a *free supply of air* is always to be admitted, for *the vapour is always to be given diluted largely with air.* This is the essential difference between the administration of chloroform and of ether. The apparatus for ether is designed so as to exclude air to a greater or less extent; that for chloroform must admit air freely.

Chloroform being so potent a drug, exact dosage is highly desirable. Nevertheless, the susceptibility of different patients is so widely different that no stereo-

typed dosage will succeed in either avoiding danger or always obtaining requisite anæsthesia. Nothing but the administrator's experience can secure this. Disastrous or inconvenient results are certain if it is thought that by any contrivance the administration of chloroform can be made a purely mechanical matter, to be carried out safely by a machine in the hands of the ignorant or inattentive. The main factor in successful induction and maintenance of anæsthesia by chloroform is the

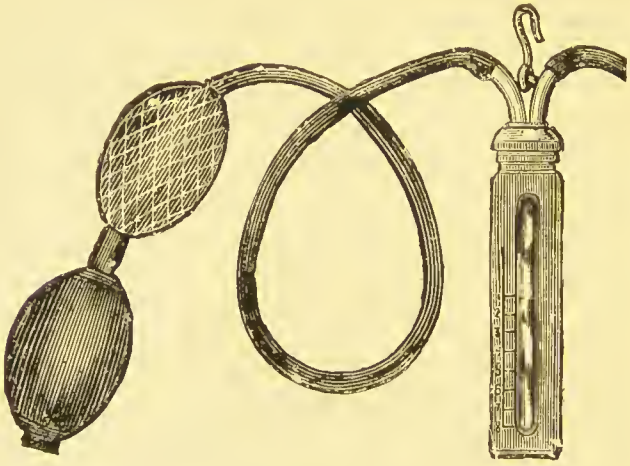

FIG. 11.

administrator's power to judge accurately the effects he is producing. These considerations affect the question of method of administration, for an experienced anæsthetist may justly prefer the open method, by which he can at will supply a very strong vapour, whereas in the hands of the less experienced undoubtedly some arrangement should be employed which makes it at least far more difficult to give a too strong dose. In short, overdosing—one great danger with chloroform—is less easily perpetrated with a Junker's inhaler (Fig. 11),

or any regulating inhaler, such as Vernon Harcourt's, than with a drop-bottle. The Junker so far meets the question of regulating the strength of vapour that, under ordinary conditions, a maximum vapour of about 3·5 per cent. can be uniformly supplied. The student is advised to familiarize himself thoroughly with the use of the Junker's inhaler.

Whether an inhaler or a drop-bottle is employed, the student, in giving chloroform, is always to observe the following rules :

1. Start with a very diluted vapour, which is gradually strengthened.

2. When anæsthesia is induced, aim at the continuous supply of a uniform vapour.

3. Keep a constant and close watch upon the respiration and colour of the patient.

4. Observe the pulse and the pupil frequently during the administration. Test the corneal reflex occasionally.

Junker's inhaler is an apparatus by means of which air is pumped through chloroform, and passes on laden with a percentage of chloroform vapour to a face-piece, where it is breathed by the patient. The bottle, holding an ounce of chloroform, is entered by two metal tubes attached to a circular lid, which screws on to the top of the bottle. Attached to the lid is a large hook, by which the administrator hangs the bottle to the breast of his coat. One of these tubes is long and passes down into the chloroform, the other quite short. The bellows or pump connects by an indiarubber tube with the upper end of the *long* metal tube ; the face-piece connects similarly with the short metal tube. Care must be taken to see that these connections are correct, or there is danger of liquid chloroform passing

to the patient's face. Similarly, in using the apparatus, the chloroform-holding bottle must never be much tilted for fear of liquid chloroform passing into the short efferent tube. Various face-pieces are in vogue with Junker's inhaler. The best is a perfectly simple metal frame, on to which a single piece of Domett or thin lint or flannel is fastened. It is really a simple modification of Skinner's mask (Fig. 12). The lint is easily fastened on, and there is thus no inconvenience in using a fresh piece for every case. The frame may be

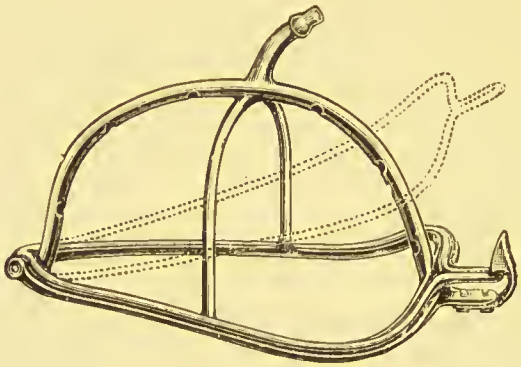

FIG. 12.

boiled without damage. A stoppered funnel by means of which the bottle may be refilled without unscrewing the lid is an additional advantage (Buxton). This is not shown in Fig. 11. In Dr. Hewitt's modification of the apparatus kinking is guarded against by the use of thick tubing.

For oral and nasal cases the face-piece is replaced by a soft metal tube, which is passed to the back of the mouth at one side. If more convenient the tube is passed to the back of one nostril. This tube is also employed when chloroform is to be given through a

tracheotomy tube, being then inserted about $\frac{1}{2}$ inch into the tube in the trachea. Sometimes it is convenient in face cases to employ Hewitt's chloroform-prop, or else a gag containing a tube for the passage of the chloroform. When not in use, Junker's apparatus should be left hanging up by the hook attached to the metal stopper of the bottle. The indiarubber tubes are then not likely to kink, as they may do if curled up in a bag. Moreover, the indiarubber parts of the apparatus must not be allowed to get stiff, as will happen if they are exposed to too low a temperature or unfrequently used. If they get rigid in this way the indiarubber parts of the apparatus must be laid before a fire for a minute or two, until the warmth renders them supple again. If proper care is not taken of the apparatus, the valve at the end of the pump may be found to be not in working order when it is wanted. Before using the inhaler test it to see that it is in proper condition.

The accessories described on p. 27 are, as always, to be at hand. The patient being prepared and placed as described (p. 30), and the examination having been made, hold the mask 2 inches from the face over mouth and nose, and gently squeeze the indiarubber ball while an inspiration is in progress. Great care is taken to begin with very gentle compressions, and the strength of vapour given is estimated by the anæsthetist previously testing it on himself. Gradually bring the mask closer to the face without increasing the strength of pressure on the ball, and squeezing only with each inspiration.

Any coughing or holding of the breath is met by allowing a breath to be drawn without an accompanying squeeze of the ball.

After about twelve breaths it will be found that the mask may be brought to rest lightly on the face.

With each inspiration now increase the strength with which the ball is compressed.

Talking gradually becoming incoherent and accompanied by movements of the limbs may now arise, but the administration is steadily continued as long as there is no holding of the breath. Sometimes a condition resembling ordinary sleep is present at this stage. More often the excitement increases, and is accompanied by some rigidity. This may cause holding of the breath, which is met by withholding pressure on the ball. The mask is kept upon the face, and chloroform is pumped in freely with each inspiration directly breathing continues again. There may be some swallowing movements, but these and the secretion of mucus are less than with ether. The excitement soon subsides, and is shortly followed by occasional incoherent mutterings, which give way to quietly snoring or to stertorous breathing. On an average it takes from four to eight minutes to obtain a condition of surgical anæsthesia. In big, muscular, alcoholic subjects, the vapour obtainable from Junker's inhaler may be insufficient to bring about this result, and must then be supplemented by drops added on to the mask. The face is slightly flushed, the pupils are moderately dilated, and pulse and respiration are more rapid than before the beginning of the administration.

The conjunctival reflex is absent, though by touching the cornea a lid reflex may still be obtained. After a few minutes the pupil settles down to a size slightly smaller than that usual with ether.

For many operations the anæsthesia now present is deep enough. Sometimes it is necessary to increase it

until the corneal reflex is also gone. This is the case with abdominal operations and with those upon the eye, as well as in uterine and bladder cases.

Chloroform must be given gradually, yet not too slowly. The administration is to be begun with a very weak vapour, but once the mask is down upon the face the strength of the vapour is to be increased and maintained.

Too strong a vapour at the beginning is dangerous ; too slow an increase in the amount of chloroform given may lead to prolonged excitement or vomiting.

The mask is kept on the face by the administrator's left hand, the little finger of which rests behind the angle of the jaw. His right hand need never exert its full strength in pumping. The ball should not be squeezed flat, but only compressed, when the strongest vapour is desired, to about three-quarters of the greatest possible compression. It is rarely necessary to keep up this strength of compression throughout an operation. The anæsthetist aims at determining the strength of vapour necessary in each case to keep the patient at the required depth of anæsthesia, and then supplies that vapour continuously. Alternations between too light an anæsthesia and a strong vapour are not desirable.

Drop-bottle and Skinner's Mask

Skinner's mask is a metal frame with a handle attached. Over the frame is stretched a single layer of Domett or thin lint. The modification pictured in connection with Junker's inhaler may always be used, as it is quite conveniently held by the stem, and the same mask is thus available for use with drop-bottle alone or with Junker's inhaler. The best form of drop-bottle is Thomas's, the stopper of which permits of

the chloroform being either given in single drops or poured in a continuous stream. The principle on which the drop-bottle and mask are employed are exactly the same as those detailed in the case of Junker's inhaler.

Start with a few drops on the mask.

Hold the mask at first quite 2 inches from the mouth and nose.

Gradually lower the mask.

Gradually increase the amount of chloroform added until about one-third of the surface of the mask is kept moist.

The *corner of a towel* or a *handkerchief* drawn through a safety-pin makes a perfectly efficient mask, but these are not so conveniently held, nor do they keep their shape so well as a Skinner's mask.

In keeping adult subjects under the influence of chloroform 1 drachm lasts about five minutes when a drop-bottle and mask are employed. With Junker's inhaler less is used. The longer the administration the less the chloroform required—that is to say, if, for the first half-hour, 1 drachm were needed every five minutes, probably for the second half-hour the same amount would only be necessary every seven or eight minutes, and would suffice for an even longer period as the length of time increased.

The condition of a person properly anæsthetized with chloroform differs from a similar state due to ether in that—

1. Respiration is less vigorous.

2. Stertor, if present, is less noisy, and the breathing is more often accompanied by a quiet snoring. Sometimes there is a high-pitched inspiratory stertor, due to some laryngeal spasm, which is rarely heard in the case of ether.

3. There is less mucus and saliva present in mouth and air-passages.

4. There is not the same tendency to congestion of face and neck; the face, in fact, generally becomes rather paler than usual after the first quarter of an hour or so. Excessive pallor usually precedes vomiting, or is a sign of over-dosing. It is easily induced in infants.

5. The pupil is smaller than with ether; it may even be very contracted. If the fourth stage, of a dangerous degree of anæsthesia, is approached it dilates, and in conditions of grave danger is generally widely dilated.

6. The pulse, which is rapid during the early stages, is in proper surgical anæsthesia from chloroform about the usual rate, or rather slower. The circulation is more easily disturbed, particularly in connection with respiratory embarrassment, than is the case with ether.

7. Shallow, very quiet breathing is much more common under chloroform than under ether.

The induction of anæsthesia with chloroform takes considerably longer than with 'gas and ether,' and the second stage, particularly with disordered consciousness, 'struggling,' and rigidity, is more likely to be prolonged. It is, in fact, more usual than not for this stage to be obvious, whereas with 'gas and ether' properly given it can generally not be differentiated.

Clonic movements occur less often than with ether. Ankle clonus can generally be elicited during the early periods of an administration as long as the anæsthesia is not of a deep degree.

Vomiting is liable to occur much more suddenly than is the case under ether. It frequently occurs before the conjunctival reflex has returned.

Very shallow breathing, or swallowing, or irregularity

of respiratory movement, generally precedes vomiting, and this is an additional reason for keeping the closest possible watch upon the way in which respiration is being performed. Moreover, breathing is often so quietly performed under chloroform that the ear is of less assistance than when ether is being used.

Spasm of the muscles of the jaws and neck is less liable to arise when once anæsthesia is fully established than is the case with ether. Nevertheless, in some persons under chloroform considerable trouble arises from spasmodic sucking back of the tongue, which is remedied by free use of ether.

The *corneal condition* is a most important guide when feeble respiration, pallor, and dilating pupil might mislead the anæsthetist into mistaking a condition of too light anæsthesia for one of imminent danger. It is by taking the symptoms together, and by realizing the extent to which he has been giving or withholding the drug, that the anæsthetist correctly estimates the condition present. Thus *danger is indicated* if—

(*a*) Chloroform has been continuously administered ;
(*b*) The pupil is moderately or very dilated ;
(*c*) The colour is pale ;
(*d*) Respiration is shallow ;
(*e*) Pulse is slow, feeble, or irregular ;
(*f*) Cornea is insensitive ;
(*g*) Pupil is inactive ;

whereas too light an anæsthesia is probably the cause of *b*, *c*, *d*, and *e* if—

(i.) Chloroform has been withheld.
(ii.) The corneal reflex is present.
(iii.) The pupil reacts to light.

The patient taking chloroform is liable to danger in several ways, which, in the case of ether, are of far less serious import. These dangers are due to—

1. Respiratory embarrassment,
2. Toxæmia from poisonous doses,

and may lead to a fatal result by means of consequent—

3. Circulatory failure.

In the first class of case danger arises primarily through interference with breathing, which secondarily affects the circulation. In the toxic cases danger is caused primarily by the direct action of the drug upon the vital centres in the medulla and upon the heart muscle.

In the *early stages* breathing may be interfered with by *muscular spasm* during the period of rigidity and excitement.

This is met by steadily continuing the administration with plenty of air, and by holding the jaw forward. If *clonic contractions* take the place of irregular and excited movements, this is an indication for withholding the chloroform. Too concentrated a vapour causes *holding of the breath*, and this may prove dangerous by preventing the elimination of chloroform vapour already inhaled. In all cases of embarrassed breathing under chloroform the danger is due to the fact that, to the deleterious effects upon the heart of a partially asphyxial condition, is added the toxic action on the dilating heart of the chloroform. Thus, an already embarrassed right ventricle which is dilating through the pulmonary engorgement consequent upon imperfect respiration is further damaged by the chloroform containing blood, and the imperfect respiration does not allow elimination

of the chloroform, the action of which increases the heart's dilatation.

Muscular subjects being particularly liable to pronounced spasm, are more exposed to the danger arising from the mechanically obstructed breathing which spasm may cause than are weaker individuals.

Reflex effects of the operation are a source of danger if anæsthesia is light, because they may take the form of respiratory spasm. The reflex effect directly upon the circulation is rarely a source of real danger, although the pulse may be temporarily affected. Shock from operative measures is much diminished by anæsthesia, and, as a matter of fact, is absent on many occasions when it is expected. It may arise both in light and in deep anæsthesia, but is usually quickly recovered from.

Laryngeal spasm, indicated by a high-pitched respiratory stridor, which is not dispelled by pushing forward the lower jaw, sometimes arises in a chloroformed subject. This may lead to considerable obstruction to entry of air, and is to be corrected by giving less chloroform and by traction on the tongue.

The dangers due primarily to respiratory embarrassment are more common in the early stages of chloroformization. The danger of *toxæmia* is more liable to arise late in the course of a long administration. It is shown by feebleness of respiration and of pulse, by pallor of the face, and by a dilating pupil with insensitive cornea. Such a condition calls for withdrawal of the anæsthetic and restorative measures (p. 91).

Susceptibility to the Action of Chloroform

There is great difference between the susceptibility of different persons to chloroform, and danger that could not be foreseen may thus arise through a dose

perfectly safe to the ordinary individual being administered to one of extraordinary susceptibility to the action of the drug. For this reason, as well as others, a very weak dose is always to be used at first, and the anæsthetist feels his way to a safe allowance for the particular patient. This indiscernible susceptibility that may be present is another argument against the advisability of stereotyped dosage and against instruments regulated for an invariable dose.

Too much stress cannot be laid upon the great need for close observation throughout an administration of chloroform. Dangerous or inconvenient conditions arise easily and quickly in a person deeply under its influence. Such conditions are anticipated and avoided, or promptly arrested if they arise, only by an anæsthetist who thoroughly appreciates the condition of his patient at every moment of the administration.

CHAPTER V

ETHYL CHLORIDE

The use of ethyl chloride before ether has been described (Chapter IV.), and I give here a brief description of the way in which ethyl chloride may be used by itself for those cases in which it is the most desirable anæsthetic. The patient should be prepared as though for ether or chloroform, as ethyl chloride is not to be regarded either from the point of view of safety, or of freedom from after-effects, as on a par with nitrous oxide. Nor should it be used, like ether or chloroform, for prolonged anæsthesia, but, generally speaking, only for cases in which an anæsthesia of about two minutes is desired. Dental cases and those of tonsils and adenoids are its special field. Almost innumerable methods and apparatuses have been employed and described for the administration of this drug. The following I have found perfectly efficient, simple, and consistent with cleanliness. Whatever method is employed, there must be for success strict limitation of air-supply and careful restriction of dose.

Administration

Fit the bag pictured in Fig. 13 on to a face-piece, such as is used with Clover's inhaler, a size being selected according to the subject. The dose of ethyl chloride in cases where the operation is to be performed after in-

halation of one dose should be : For children up to four years of age, 2 c.c. ; up to ten years, 3 c.c. ; for older children and women, 4 c.c. ; and for men, 5 c.c. This absolute rule has, of course, to be varied at discretion

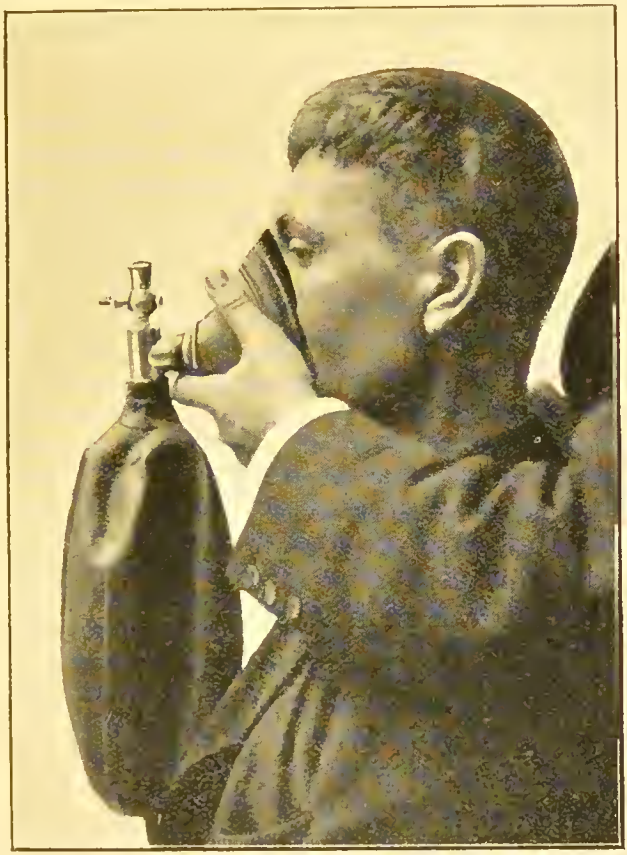

FIG. 13.

in accordance with the physique or habits of the individual. It is important, however, to minimize the dose.

The patient may be lying or sitting, in accordance with the operator's requirement. In any case a small mouth-prop is placed between the teeth. The dose

having been sprayed into the bag, which is allowed to hang down, the face-piece is now gently, but accurately, adapted to the face. Quiet breathing is recommended, and, expiration being seen to adequately distend the little bag, this is raised, till at the third breath it is in a line at right angles to the face. Unconsciousness is

FIG. 14.

induced with remarkable rapidity. Children are often unconscious after the second breath from the bag, and adults commonly after four or five. There is generally no cyanosis, the face being merely flushed. Often there is some spasm of limbs, but clonic movements, such as are seen with nitrous oxide, are of the rarest occurrence.

The best *test for the presence of anæsthesia* is the condition of the eye. The globe is fixed, the conjunctival

reflex absent, and the pupil generally dilated. Stertor is generally present, and, if so, is an absolute proof of anæsthesia. In children it is often absent, or so soft as to be heard with difficulty. The average *duration of anæsthesia* with ethyl chloride given in the above doses and as just described is about seventy-five seconds. *Recovery* is rapid, often associated with excitement, and not nearly so free from after-effects as in the case of 'gas' (see Chapter XI.). After every administration the face-piece is to be cleansed with 1 in 40 carbolic lotion, and the bag washed out with warm water.

Unusual Symptoms

Occasionally induction is accompanied by an extreme excitement. This is particularly liable to occur if air is not rigidly excluded. Similarly, intense spasm of limbs and of the body is occasionally met.

The inhalation of ethyl chloride is occasionally followed by a condition of faintness, that must be promptly treated by placing the patient horizontal, with the head to one side, and rubbing the lips and face briskly.

The great convenience of ethyl chloride, through its portability, rapidity of action, and the simple method of its administration, must not conceal the fact that it has been associated with many fatalities (*British Dental Journal*, November 1, 1905).

It should not be used in cases such as those of cellulitis of the neck, where there is mechanical narrowing of air-passages, nor in patients with feeble action of the heart. It is well suited to the aged, and is of great service for such procedures as the removal of packing from the abdomen, or other painful dressings in persons in bed after operation.

CHAPTER VI

ANÆSTHETICS IN SUCCESSION AND IN MIXTURES

Besides their individual use, the chief anæsthetics may be used in various mixtures, and also in succession to one another in the same case. The successive uses of *nitrous oxide and ether*, *and of ethyl chloride and ether*, have been described, and a few words may here be said about the use of chloroform and ether in succession. Either chloroform may precede ether or ether chloroform. The student is not advised to change from one anæsthetic to another in the same case until he has had considerable experience; at any rate, he should not change from ether to chloroform, although in expert hands this change is often highly desirable. This is particularly the case in *abdominal surgery*, when very often the best plan is to induce anæsthesia with 'gas and ether,' and change early to chloroform. A safe and quick induction is thus secured, as well as the advantage that chloroform offers in the way of *quiet respiration* during operation and *absence of subsequent chest trouble*.

When changing from ether to chloroform particular care is needed that no respiratory embarrassment arises, owing to the presence of mucus occasioned by the ether. It may happen that mucus, which, owing to

the vigorous respiration with ether, offered no obstacle to air entry so long as this anæsthetic was employed, becomes a serious impediment to the gentler breathing under chloroform. Again, the chloroform must be sparingly given at first, as too much will easily be inhaled while the vigorous respiration caused by the ether is going on.

When to change from Ether to Chloroform

It is a good plan either to make the change as soon as the patient is anæsthetized with ether, before the operation is begun, and to let him give a cough or two while the chloroform is started (Hewitt), or else, if the change is made after he has been under ether for some time, to open the mouth and sponge out the pharynx before chloroform is given freely.

It is not often necessary to *change from chloroform to ether* in the course of an operation, though such a change is sometimes rendered advisable by feebleness or collapse. The proceeding is simple: a Clover's inhaler, turned to '$1\frac{1}{2}$' or '2' may be applied straightway to the patient, who is already anæsthetized with chloroform. Allow air to be freely admitted at first until all the chloroform has been eliminated. Ormsby's inhaler or a Rendle's mask may be used with advantage instead of Clover's apparatus when ether is applied to the patient already fully under chloroform.

During a chloroform administration, if stimulation is desired, 1 drachm of ether may be poured upon the flannel mask from time to time, and such a practice is often of service. When nitrous oxide is not used to introduce ether, the unpleasantness of the latter is often avoided by starting the administration with a few drops of chloroform. It is wiser, however, to employ either

the *C.E. or the A.C.E. mixture* for this purpose, and to avoid using chloroform for just that early part of the administration when it is most likely to give trouble or danger. The use of these mixtures as preliminaries to ether or to chloroform in the case of young children is described on p. 102.

The A.C.E. mixture consists of alcohol, chloroform, and ether in the respective proportions of one, two, and three. **The C.E. mixture** is 2 parts of chloroform to 3 of ether. The latter is to be preferred for its greater simplicity. The effects of the two are very similar. The advantage of the presence of alcohol is doubtful, and it is perhaps an additional cause of after-effects (Hewitt). The mixture is always to be made fresh for every case. Large quantities are not to be prepared—4 drachms of chloroform and 6 drachms of ether shaken up in a drop-bottle are a convenient quantity. In using the mixture *small quantities at a time* are to be added to the mask or inhaler. In this way the objection to mixtures—that the constituents evaporate at different rates, and that therefore at first only ether, later only chloroform, may be inhaled—is got over, for by using small doses at a time the whole of one dose, both ether and chloroform, will be inhaled before the rest is added. The mixture is to be given from a *drop-bottle* on a *flannel mask*, just as in the case of chloroform. The student is, in fact, to administer the mixture on the same principles that he observes in the case of chloroform. *Free air-supply, no closed inhaler, gradual administration*, and *uniform dosage when anæsthesia is obtained*, are to be his aim. In the case of children, if the mixture is used throughout, the flannel mask may be employed all the time. With adult subjects it is better, as anæsthesia approaches,

to substitute a Rendle's mask or a cone for the Skinner's mask, as the very free evaporation and air-supply insured by the former may make it difficult to offer a strong enough dose. A few drops are sprinkled on the mask to begin with, and by the time that it is brought to rest upon the face the mixture is added in doses of ½ drachm at a time, and this rate of addition continued when the cone is substituted. As a matter of routine, begin with 10 drops on the mask, which is held 2 inches from the face. Gradually lower the mask, adding the mixture so that the moisture of

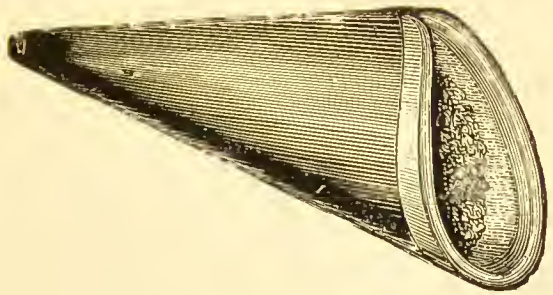

FIG. 15.

10 drops is constantly present. On an average 1 drachm is needed about every three minutes. The mixture given in this way is particularly useful for very fat patients, bronchitic and emphysematous people, the subjects of dilated heart, big, plethoric, and alcoholic subjects.

With the latter class it has, of course, to be very much more freely poured upon the cone than is indicated above. From time to time pure ether may be added instead of the mixture.

More convenient than ether, more safe than chloroform, and very generally applicable, the *C.E.* mixture

has a great deal to recommend it as a routine anæsthetic in such conditions as those of country practice. The necessary articles are :

A 10-ounce bottle of ether.
A 10-ounce bottle of chloroform.
A 4-ounce drop-bottle, in which the mixture is to be made fresh.
Skinner's mask.
Large felt cone (Fig. 15) or Rendle's mask.

These are easily carried in a small bag.

The mixture is not so unpleasant to inhale as ether, and some persons prefer its vapour to that of chloroform. In safety it stands between the two—less safe than ether, and safer than chloroform. The symptoms during induction and during anæsthesia in like manner resemble those due to chloroform and to ether. There is less mucus than with the latter, less tendency to shallow breathing and to collapse than with the former. Mixtures of chloroform and ether in other proportions are also employed, and special advantages are claimed for the mixture of chloroform 1 part with ether 3 parts (Silk).

CHAPTER VII

CHOICE OF ANÆSTHETIC

The great majority of subjects for operation *can* be anæsthetized with any one of the agents hitherto considered. We must, therefore, decide which one of these agents to use as a routine anæsthetic, unless there are special indications for the use of another. In thus deciding we shall be mainly influenced by consideration of—

1. The safety of the patient.
2. Convenience of the operator.
3. Comfort of the patient.
4. Nature of anæsthesia obtainable.

The first of these considerations must carry by far the greatest weight, and it is this chiefly that leads us to *choose ether as our routine anæsthetic.* Ether has been proved by the collected experience of many thousands of cases to be at least five times less dangerous than chloroform. Mixtures containing chloroform are less dangerous than it, but more so than ether. Nitrous oxide, as far as safety goes, is superior even to ether, but in this case the disadvantages arising from the nature of the anæsthesia and from the lack of portability of the agent in large quantities put the anæsthetic out of court so far as operations other than quite short ones are concerned. It has been pointed out that ether

is most rapidly and most pleasantly given if preceded by nitrous oxide gas. The use of these two agents in combination requires frequent practice. While those who are frequently administering anæsthetics, therefore, will make gas and ether their routine anæsthetic, *the practitioner whose use of anæsthetics is occasional only will be wise to perfect himself as far as possible in the administration of ether as described* (p. 30), *and employ this for all his ordinary cases.*

Ether is to be thus widely adopted because—

1. It is the safest general anæsthetic with which complete relaxation of muscles and perfect anæsthesia can be maintained for any length of time.

2. After-effects, if unpleasant, are not often serious. Sickness is never so severe as that which sometimes follows chloroform. Lung troubles are avoidable by care in selection and management of cases.

3. The apparatus required for efficient administration of ether is not elaborate or inconveniently cumbrous.

4. The great majority of healthy persons can be anæsthetized with ether if the proper method is employed.

Ether falls into disuse in general practice largely because the method of its administration is not properly learned, and because, attracted by the greater convenience of chloroform, practitioners are wont to ignore its undoubted danger. Even among healthy persons, however, undergoing operations of no extraordinary nature, there are some for whom ether is not the most suitable anæsthetic, and we must now point out its limitations as a routine anæsthetic. This will be most simply done by considering generally the further points that guide us in choosing our anæsthetic in any parti-

cular case. The chief questions to which attention must be paid are :

1. The nature of the patient and his condition at the time.

2. The nature and site of the operation.

3. The patient's previous behaviour as regards anæsthetics, if there has been opportunity of observing this.

The Nature of the Patient

People differ in their behaviour towards anæsthetics in a great variety of ways, and it is only by wide experience that the anæsthetist learns to make at first sight a correct judgment as to what that behaviour will be. The differing behaviour depends both upon the physical and the mental, or psychical, nature. Because a person is in perfect health and of fine physical development it by no means follows that he will be an easy subject to anæsthetize. In fact, the stronger a subject is, the more difficulty, as a rule, in anæsthetizing him, and the greater the muscular development, the more prone are mechanical difficulties connected with respiration to arise. It is the red-faced, well-developed athlete in whom muscular spasm is most likely to occur and to give trouble, particularly if he has strong jaws and a perfect set of teeth. Similar results may be expected in any short-necked 'plethoric' or alcoholic individual. Spasm of the jaws and much congestion of tongue and fauces are particularly liable to arise in these persons during the induction of anæsthesia, and it is a wise rule in such cases, if ether is used, before applying the face-piece to insert a small prop between the teeth. The congestion and spasm may make it necessary for the mouth to be opened and the tongue drawn out. If no prop is inserted and the teeth are good and firmly

clenched by spasm of the powerful jaws, an undesirable sacrifice of one or more teeth will have to be made to allow of the necessary insertion of a gag. The shape of jaw and arrangement of the teeth is here of importance. Difficulty is particularly liable to arise in the subjects of 'superior protrusion,' in whom the lower jaw cannot be brought forward till the two sets of teeth meet, and when the teeth inter-digitate irregularly. In the perfectly edentulous, too, difficulty may ensue from the collapsing of the cheeks, and in these cases also a prop may be necessary, and can easily be inserted during anæsthesia. Similarly, if there is obvious and extensive *nasal obstruction*, a prop should be inserted before beginning the administration of gas and ether or ether. Inconvenient symptoms like those just alluded to are far less likely to arise in pale, weakly individuals, who are from every point of view easier subjects for anæsthetization than the robust. Similarly, generally speaking, women are more easily anæsthetized than men. They are more subject to emotional excitement during the second stage and during recovery, but trouble from muscular spasm is far less frequent in their case.

Trouble such as we have been considering is much increased by cyanosis, and in well-marked cases it may be best to avoid ether—certainly gas and ether—simply on account of the air limitation involved. The muscular spasm leads to such obstructive embarrassment of the breathing that it is most undesirable to increase the partial asphyxia by any limitation in supply of air. Ether alone may, however, generally be very successfully given to the class of patient with whom we are concerned, *provided that air is supplied much more freely than usually*. With Clover's apparatus, for instance, the

bag should be 'off' after very few breaths. It is to these cases of big, muscular, full-coloured individuals that the aphorism is applicable of 'plenty of anæsthetic and plenty of air.'

When ether is not successful even with free air-supply, the *C.E.* mixture is to be freely given from a Rendle. *Muscular, full-coloured subjects usually require large amounts of whatever anæsthetic is used.* The same remark applies to all who are accustomed to use alcoholic drinks freely, and to those who smoke much. Cigarette smokers are particularly liable to persistent coughing when taking ether, and to avoid this gas may have to be more freely used in the induction than is generally necessary.

Very fat persons are not good subjects for long ether administration. In inducing anæsthesia with them, too, gas is to be sparingly employed. Generally the *C.E.* mixture is most suitable for these subjects, if the operation is to last longer than about a quarter of an hour.

Neurotic, hysterical, nervous, and excitable people have a characteristic behaviour under anæsthetics, but their condition does not much affect the question of what agent to employ, except in this particular—that they may be very unwilling to submit to the close-fitting face-piece of an ether inhaler. In such a case it is often best to start the induction with drops of *C.E.* upon a Skinner's mask, held at first some inches from the face. When consciousness becomes dulled after a minute or two the Clover's inhaler, turned to '2,' may be quietly placed upon the face and anæsthesia instituted under ether. One marked peculiarity of these subjects is that complete muscular relaxation is more difficult to maintain than ordinarily. They remain, even in deep anæsthesia, peculiarly liable to spasmodic contraction of

muscles. Reflex excitability is abolished with greater difficulty than in other cases, and it is important that operation should not be begun till deep anæsthesia is present. The same is seen in connection with painful lesions that have existed for some time, especially in connection with the urino-genital organs. Reflex excitability in connection with painful lesions may be abolished under anæsthetics only with great difficulty. In stricture cases, for instance, it sometimes happens that when instruments are passed, directly the instrument reaches a particular spot reflex spasmodic inspiration is set up, even though the anæsthesia is of a very deep degree. Similar variation in the character of the breathing is often seen when the rectal sphincters are dilated, or when the uterus is dragged upon.

Very frightened, nervous people are much more safely anæsthetized with ether than with chloroform. Even without anæsthetics such people have succumbed to fright, and the chances of such a catastrophe are certainly not diminished by chloroform as they probably are by ether.

Condition of the Patient at the Time of Operation

An elaborate investigation at the anæsthetist's hands is not usually desired. He will be informed, as a rule, of any grave pre-existing medical disorder, and the influence which this may have on the choice of anæsthetic is briefly shown hereafter (p. 78 *et seq.*). On two most important points, however, the anæsthetist must always fully inform himself—viz.:

1. The manner in which the respiration is performed.
2. The state of the circulation.

The student should acquire the habit of looking keenly at every subject about to be anæsthetized, and of gaining an impression as to his physical nature, as to the ease or difficulty, rapidity or slowness, depth or shallowness of his respiration, and as to the vigour or feebleness of his circulation. A good opinion on these points can be formed if the way in which the patient lies, moves, speaks, and breathes, are noted, and his colour closely observed. The pulse is then to be felt, and the stethoscope must be applied to the chest if there is any suggestion of abnormality within the thorax.

Respiration.—The respiratory condition influences most directly the choice of an anæsthetic. Broadly speaking, *when dyspnœa is present, nitrous oxide, 'gas and ether,' and ether from a closed inhaler, are always to be avoided.* This is invariably the case when the dyspnœa is of laryngeal origin, as, for instance, in cases of diphtheria or œdema of the glottis, or when it arises from pressure on the trachea, particularly in cases of cellulitis of the neck. Such patients must have the freest air-supply with their anæsthetic. Moreover, the swelling and secretion of mucus caused by ether would seriously aggravate the dyspnœa. Usually chloroform alone is best for these cases, or if the general condition is very serious the *C.E.* mixture. Chloroform is also to be chosen when respiratory difficulty is due to recent acute disease within the chest, as acute bronchitis, broncho-pneumonia, or pleural effusion. When the heart is also acting rapidly and feebly anæsthesia is dangerous, and the addition of ether, by occasionally pouring some on to the mask, or by using *C.E.* mixture, may be of advantage. The danger of all anæsthetics is greatly enhanced by the presence of dyspnœa, and whenever orthopnœa is present the risk is further in-

creased. When anæsthesia is induced the extraordinary muscles of respiration are paralyzed, and respiration that has perhaps been efficiently carried on only by their aid may cease entirely. Care must be taken to place the patient in that position in which he finds that respiration is most easily performed.

When without true dyspnœa respiration is embarrassed and quick—as, for instance, in cases of acute peritoneal lesions, or of large abdominal tumour—there is not the same objection to the use of ether, and with these patients anæsthesia is generally conveniently induced by gas and ether. The way in which an abdomen, rigid and contracted with pain, softens and moves freely with respiration as soon as anæsthesia is established, is often a remarkable phenomenon in cases of acute, grave intra-abdominal lesions.

Whenever respiration is performed imperfectly or with difficulty the cause of the trouble must be carefully ascertained if the anæsthetist is not already fully informed.

When chest affections are the source of the trouble, chloroform will usually be the best anæsthetic to choose. This is certainly the case with—

1. Active tuberculosis.
2. Recent or extensive pleural effusion or empyema.
3. Acute bronchitis.

In cases of active phthisis ether must be rigidly avoided. Its use has greatly aggravated the lung disease on several occasions. In empyema cases of old standing a mixture of chloroform and ether may be used, or even ether alone, when the empyema is small. The *C.E.* mixture is to be preferred to chloroform alone in cases of *dyspnœa associated with heart disease*. Particularly patients with emphysema, bron-

chitis, and fatty hearts, are more safely anæsthetized with *C.E.* mixture than with chloroform alone.

Valvular disease of the heart does not *per se* necessitate any departure from the routine anæsthetic unless compensation is broken. The congested lungs, labouring right side of heart, and hurried respirations then demand an open form of administration with free air-supply, and the case is best met by the *C.E.* mixture.

Condition of the Circulation.—When the heart's action is feeble, as in conditions of collapse from recent injury or grave illness, ether is particularly advantageous. The colour and circulation improve remarkably. There is danger, however, in the reaction that follows the stimulation of the anæsthetic, and special care must be taken that the proper anæsthesia is maintained with as little of the drug as possible.

Atheromatous arteries and very high tension pulses should lead to the use of chloroform. The induction of anæsthesia in such cases is, however, best conducted —in expert hands, at any rate—by gas and ether. The smooth rapid entry into unconsciousness and anæsthesia, devoid of struggling and of cyanosis, which can almost invariably be secured with gas and ether skilfully used, offers less risk, despite the stimulation of the ether, than the rigidity and struggling that often inevitably accompany the 'second stage' of chloroform inhalation.

Intestinal obstruction cases in a late stage—as, for instance, strangulated hernia where vomiting has been present for many hours—are sometimes cited as instances in which a general anæsthetic is to be avoided. The reasons given are :

1. The collapsed state of the patient.
2. Danger from inhalation of vomit.

The second danger is entirely averted by care on the anæsthetist's part (see p. 96); the first is materially diminished by the use of ether. Generally speaking, it may be truly said that there is no patient who can stand operation, but cannot stand an anæsthetic. Anæsthetics diminish shock, and, in almost every case where operation must be performed, no matter how grave the condition of the patient, his chances are enhanced rather than prejudiced by the proper anæsthetic properly given.

Conditions not necessarily obvious that may influence the Choice of Anæsthetic

It is presumed that the anæsthetist will have been informed of these, and he must then select his drug in accordance with that information.

1. **Phthisis,** though active, may not cause any noticeable alteration in respiration. Its influence on the choice of agent has been discussed.

2. **Renal Disease.** — Ether increases albuminuria more than chloroform does. The latter is to be chosen, therefore, when albumin is known to be present. Moreover, cases have occurred in which an acute œdema of the lungs occurring under ether has been held responsible for the fatal issue. Such cases have been held to be of renal origin.

Diabetes.—Diabetic coma has followed the use of anæsthetics. Whatever anæsthetic is to be used, the patient should be previously treated in such a way as to reduce the amount of sugar to the lowest possible point. Recently it has been asserted that ether should always be chosen for diabetics.

Previous Drugging. — Patients for operation are sometimes under the influence of drugs that have been

used to treat the condition for which surgery is now demanded.

Opium is the chief of these, and its presence is usually obvious from the contracted pupils that it causes. Either ether or chloroform may be used in such a case, and the anæsthetic, whichever it is, is to be sparingly given. The condition of pupils ordinarily found with ether and chloroform does not hold in these cases.

Alcohol.—Ether is generally the best anæsthetic for those who are habituated to alcohol. It has to be freely used. The hearts of such subjects are prone to fatty change and to dilatation, and chloroform is therefore to be avoided, or given in mixture in their cases. Patients actually under the influence of alcohol, if much has been taken, may require an unusually small, rather than a particularly large amount of the anæsthetic.

Cerebral Conditions.—Cerebral tumours, cerebral abscesses, cerebral hæmorrhage or compression of the brain may have already induced a partially comatose condition. In such cases chloroform is to be employed, and in very small quantities. Scarcely any anæsthetic at all is usually needed, and, as a rule, the administration need not be begun before the beginning of the operation. The same applies in the drowsy condition following epileptic attacks. The fact that a patient is subject to **epilepsy** does not influence the choice of an anæsthetic for him. **Insanity** may in the same way be disregarded. The subjects of recurring attacks of insanity will be liable to an attack after anæsthesia, but it makes apparently no difference by what agent this is induced.

Pregnancy, Lactation, and Menstruation.—For women in labour chloroform is particularly well adapted, because of the ease with which a condition of analgesia

without deep unconsciousness may be maintained by its use. When full surgical anæsthesia is required, chloroform should be soon replaced by ether. Similarly, when a surgical operation is to be performed in the later months of pregnancy, anæsthesia should, as a rule, be induced by chloroform and maintained by ether. Nitrous oxide is to be avoided, or, if employed, is to be given with oxygen. In the early months of pregnancy no departure from routine rule need be made.

Lactation has no bearing on the choice of anæsthetics. Naturally, a baby must not be put to the breast till its mother is entirely rid of the anæsthetic. The best plan is to let the baby be bottle-fed for the twenty-four hours following operation, unless this has been very short.

Menstruation. — Though operations are usually avoided during menstruation, an anæsthetic, if required, may be harmlessly given under this condition.

Sleep.—When, as occasionally happens, it is desirable to anæsthetize without awakening, chloroform should be used. It should be given very gradually from a drop-bottle on a Skinner's mask, which is held at first a considerable distance—6 inches or so—off the sleeper's face.

The Nature and Site of Operation

Head, Neck, Face, and Pharynx.—In small operations upon the surface the general rule may be adhered to—*i.e.*, nitrous oxide for the very short, gas and ether for the longer cases. When there is likelihood of considerable hæmorrhage, the congestion almost inevitably caused to some extent in these regions by the use of ether renders chloroform preferable for long operations. Anæsthesia is best induced, however, in the ordinary way, the chloroform being substituted directly the third stage is reached.

Many operations upon the **lips, cheeks, and tongue** can be completed under ether, the patient being fully anæsthetized with gas and ether, and the ether kept on for several minutes before the operation is begun, when it is entirely removed.

In more formidable operations such as **removal of jaw, and complete removal of tongue,** the same plan is to be adopted, and anæsthesia further maintained by chloroform given from a Junker's inhaler. The soft metal nasal tube, or a silk catheter of the same size, is to be fitted in place of the mask, and passed well to the back of one nostril, or of the upper side of the mouth. The preliminary administration of ether is not to cease till deep anæsthesia is obtained. If a lateral position is not employed (p. 97) the anæsthetist must frequently clear away blood from the pharynx. A small sponge grasped in the blades of his tongue forceps is a convenient instrument for the purpose. 'Sponge holders' are to be avoided. Moreover, if from the patient's position blood will easily be inhaled, the anæsthesia should not be so deep as to abolish the cough reflex.

Tonsils and Tonsils and Adenoids.—Tonsils may be removed under gas, or, better, gas and oxygen, or ethyl chloride. Certainty and celerity are necessary on the surgeon's part. Either a prop or a Doyen's gag is to be inserted before the administration is begun, that no time may be wasted in opening the mouth widely the moment the face-piece is removed. If a prop is used, a Mason's gag is inserted and the prop removed directly the face-piece is taken off. The anæsthetist, standing on the opposite side from the surgeon, steadies the gag and presses forward the tonsil from behind the angle of the jaw.

Both the tonsils and adenoids may be removed at one

sitting under these anæsthetics if the operator is quick and the anæsthetist knows exactly what to do. Many surgeons prefer to operate deliberately, and then ether is to be used. By a short administration of gas and ether—*i.e.*, under ten minutes—an anæsthesia of several minutes, with convenient relaxation, is easily secured. No gag or prop need be previously inserted unless the nasal obstruction is pronounced, and the after-effects from so short an inhalation of ether are almost negligible. (For position in these cases see p. 98.) If a still longer anæsthesia is desired, this is obtained by continuing the administration with chloroform from Junker's inhaler and tube.

Unless well experienced, the anæsthetist is particularly recommended to avoid chloroform for these operations. If chloroform is used, the same position must be employed throughout the operation. Under ether the position may be changed from a sitting to a lying one, etc., according to the operator's wish.

Extraction of many Teeth is to be conducted on just the same principles—a full preliminary dose of gas and ether, succeeded by chloroform from Junker's inhaler and a tube, if the anæsthesia from the ether is not lasting enough when the Clover is abandoned. Ethyl chloride suits many of these cases.

Operations for Cleft Palate have often to be conducted under chloroform throughout, the mucus and congestion excited by ether hampering the surgeon. If, however, the surgeon does not object, there are the same advantages as in other cases in a preliminary use of gas and ether, or *C.E.* mixture with the very young. Infants must be most carefully watched during staphylorrhaphy. Deep chloroform anæsthesia is necessary, and is often accompanied by pallor and respiratory

depression. Care is usually required to keep the lower jaw from falling and causing the base of the tongue to obstruct the gentle breathing.

In Nasal Operations the same considerations apply as were mentioned in the case of tonsils and adenoids. It is always advisable in these cases to have the mouth slightly opened by a gag or prop from the first. Blood can thus be easily reached through the mouth, and a tube inserted for continuing the administration with chloroform when necessary (see also p. 99).

In Eye Operations chloroform is best used throughout, to avoid conjunctival congestion, except in the case of enucleation, when the patient should be well anæsthetized with gas and ether. The apparatus being then removed, the operation can generally be completed without further anæsthetic. If it is necessary to prolong the anæsthesia, chloroform can be most conveniently administered from a Junker's inhaler, which will allow the anæsthetist to keep out of the way of surgeon and assistant. A similar proceeding is usually best in long operations **in the neighbourhood of the Ear**—*e.g.*, in mastoid cases. In eye cases, owing to the head being necessarily kept in the middle line, it is often necessary to support the lower jaw from behind either angle, and to take special care that sufficient vigour of respiration is maintained.

Operations within the Skull are best performed under chloroform, but here again there is generally no reason to avoid the advantages gained by inducing anæsthesia with gas and ether, so long as the anæsthetist allows time for the preliminary congestion to pass off before the operation is begun. The use of **Morphia before the Administration** has been particularly recommended in these cases, vascular contraction being

the advantage claimed. The susceptibility of the patient to morphine should be previously ascertained, and the injection, usually of $\frac{1}{4}$ grain, should be made twenty minutes before the administration is begun. The anæsthetic is to be used very sparingly, and discontinued for a little as soon as anæsthesia is established. With patients who are feeble, semi-comatose, or the subjects of any respiratory difficulty, the additional risks from morphine outweigh its advantages (Hewitt).

Operations upon the Neck are often attended with difficulties of respiration. This arises sometimes from the dragging or pressure upon the deep structures necessitated by the surgical procedure. In the subjects of **enlarged cervical glands** there is special tendency to excessive secretion of mucus, even throughout the operation, and to cyanosis. Chloroform is usually to be used for maintaining anæsthesia, and great care is required to obviate danger when respiratory embarrassment arises from the operator's manipulations. The possibility of air entering the veins is to be remembered. If this accident occurs it is attended by profound shock, and prompt remedial measures are called for (p. 95).

Operations upon the Thyroid Gland may be attended with copious hæmorrhage, which will be less encouraged by chloroform than ether. When the thyroid condition causes any dyspnœa from pressure on the trachea chloroform is to be used throughout, otherwise anæsthesia is to be induced with gas and ether, and maintained with chloroform.

Cases of severe **Cellulitis of the Neck** (*Ludwig's angina*) are among the most formidable for the anæsthetist. Nitrous oxide and ethyl chloride are never to be used. Chloroform or *C.E.* mixture is best, for very free supply of air is to be allowed with whatever anæs-

thetic is used, and the anæsthesia is to be light. Death has occurred in one of these cases under gas and ether before the operation was begun.

Operations upon the Larynx and Trachea.—When any dyspnœa at all is present chloroform only is to be used, otherwise the administration may be begun with *C.E.* and continued with chloroform. Ether is to be avoided.

When the administration is to be continued after performance of tracheotomy, as, *e.g.*, in removal of larynx or laryngeal growths, chloroform is to be pumped down the tracheotomy tube from a Junker's inhaler, the nasal tube of which is inserted about $\frac{1}{2}$ inch down the tube in the trachea. Respiration is generally very quiet under these circumstances. When urgent dyspnœa has been present for some time, as is often the case in diphtheria, respiration may entirely cease almost before anæsthesia is established. The surgeon will open the trachea with all possible expedition, and as soon as a tube is in the trachea the anæsthetist must compress the chest and start artificial respiration if breathing does not begin again spontaneously. A very considerable interval may pass without any respiration, and still recovery follow. When the removal of intralaryngeal growths is attempted without preliminary tracheotomy, breathing is often temporarily arrested at the moment of operation.

Operations affecting the Pleura or Lung.—In these cases there is usually some, often great, respiratory difficulty. Nitrous oxide and all closed apparatus are to be avoided. Although ether alone is therefore not to be employed, yet chloroform alone is not always the safest anæsthetic, for the patient's general condition is sometimes so critical that the use of a little ether with the chloroform is desirable. In acute cases of empyema

and in those where there is a large amount of fluid generally chloroform must be used alone. Yet even in these cases there is sometimes an advantage in the greater vigour of respiration that ether calls forth. Much depends upon the condition of the other lung and upon the general condition in selecting the best anæsthetic for chest cases, and it must not be assumed without hesitation that chloroform is necessarily to be used for them all. A deep degree of anæsthesia should never be maintained in these cases after the skin incision has been made.

Breast Cases.—Long administrations of ether are here undesirable because of the risk of bronchial trouble through the difficulty of coughing with the chest tightly bandaged during recovery from the anæsthetic. Gas and ether, followed after ten minutes or so by chloroform, is best.

Abdominal Operations have special relation to the anæsthetic used for two reasons :

1. The nature of the respiratory movements directly affects the abdomen, and thus the site of the operation may be much interfered with if the breathing is straining or exaggerated.

2. There is special liability to lung trouble afterwards because of the difficulty of coughing owing to the wound and to bandages.

It would appear, therefore, that chloroform, which permits, as a rule, of quieter breathing, and which is less liable to be followed by bronchitis, should be chosen for abdominal operations. In accordance with the principle laid down, it should be preceded by gas and ether, or, if there are special reasons against this, by *C.E.*

To get the best possible condition for the operator

a deep degree of chloroform anæsthesia is desirable. Moreover, all *obstruction to breathing and cyanosis* are to be scrupulously avoided, as they prejudice the quiet, soft condition of the abdominal walls. No cases require greater care and experience if the best result is to be achieved. The anæsthetist of small experience is advised to give gas and ether, and continue with ether, or to give *A.C.E.* throughout, according to which anæsthetic he is most familiar with, and not to attempt to change to chloroform. It is particularly in operations affecting the upper part of the abdomen—*e.g.*, stomach and gall-bladder cases—and in bladder cases that a perfectly quiet, relaxed condition of the abdominal wall is essential to the operator's convenience.

Rectal Operations.—Deep anæsthesia is always required. There is particular liability to reflex disturbance of breathing, and surgical shock is common in big excision cases. Ether is the anæsthetic *par excellence* for rectal cases. Objection to it may occur, of course, from the patient's general condition, as, *e.g.*, in cases of fistula with phthisis.

CHAPTER VIII

DANGERS AND TROUBLES INCIDENTAL TO ANÆSTHESIA

DANGEROUS or inconvenient conditions which the anæsthetist is required to treat arise from :

I. **Obstruction to Respiration,** due to—

(*a*) Foreign bodies (blood, mucus, loose teeth, etc.).
(*b*) Congestion of tongue, fauces, etc.
(*c*) Spasm of muscles of jaw and neck.
(*d*) Collapsing cheeks in the edentulous.
(*e*) Laryngeal spasm.
(*f*) General respiratory spasm.

II. **Depression or Failure of Respiration,** due to—

(*a*) Toxic action of the anæsthetic—overdose.
(*b*) Reflex effect of operation.
(*c*) Condition of patient—chest cases, laryngeal cases.
(*d*) Position of patient.

III. **Depression or Failure of Circulation.**

(*a*) Toxic action of anæsthetic—overdose.
(*b*) Reflex effect of operation.
(*c*) Onset of vomiting.
(*d*) Condition of patient—feebleness, recent shock, etc.

These conditions, except (*a*) to (*d*) in Class I., are more common with chloroform than with ether. They may be met with in any case, but persons of certain types are specially liable to all the dangers arising from spasm of muscles and congestion affecting the upper air-passages, while others, usually from illness, are more subject to the troubles indicated in Classes II. and III.

To a certain extent, therefore, the probability of trouble and of its nature may be foretold.

Preventive Measures may therefore be adopted.

Thus stout, thick-necked, alcoholic men with strong jaws and good teeth, in taking any anæsthetic are particularly liable to become very congested in tongue and fauces, and to have the mouth clenched with spasm (p. 74). In other persons the contour of the jaws does not allow the lower jaw to be pushed forward, or this may be due to much fat about the chin and neck, or to swelling of the neck as from glandular tumours or cellulitis. In all such cases a small prop or the closed blade of a gag should be inserted into one angle of the mouth before administration is begun. The same precaution is to be taken in all cases where there is any considerable amount of *nasal obstruction*, as, for example, from adenoid growths, large tonsils, or nasal spurs.

When spasm and congestion arise they are to be met first by *pushing forward the jaw from behind the angles.*

If this is not enough, *the mouth is to be opened with the gag, and the tongue drawn out with tongue forceps.*

The anæsthetic being continued, and given with free supply of air, the spasm will generally subside as anæsthesia becomes established, but it not infrequently happens in the stout, thick-necked individuals, and also

in the edentulous, that throughout the operation the mouth must be kept open, the lower jaw held well forward from behind, and the tongue forceps used from time to time, if not almost continuously.

The treatment of *foreign bodies* is obvious—the head is to be kept well on the side, and the offending materials sponged out or removed with the finger. When a loose tooth or such-like object is inhaled, as may happen from want of care, particularly in the dental chair, the patient must be inverted. The first step is to pass the finger immediately to the back of the mouth, and see whether the lost object cannot be picked out. If it cannot be discovered and if it has certainly not been ejected from the mouth inversion must follow.

If **Laryngeal Spasm** arise—a much less common complication than the spasmodic states already referred to—rhythmic *tongue traction* is to be employed, and a finger passed to the back of the pharynx. The advent of laryngeal spasm may be indicated by a high-pitched 'crowing' noise with inspiration. Laryngeal spasm requiring treatment only occurs under chloroform, practically speaking, and is an unusual cause of difficulty even with this anæsthetic.

In very exceptional cases general spasm of the respiratory muscles follows the spasm initiated by blocking of the air-way. In such cases *tracheotomy must be performed* and followed by inflation of the lungs.

Commencing Failure of Respiration is perhaps the commonest condition arising during anæsthesia, due partly or wholly to the anæsthetic, and requiring attention from the anæsthetist. It is generally shown by the supervention of pallor or of blueness of the face, with feebleness of the respiratory movements. These symptoms, in combination with an insensitive cornea, always

herald danger. The course to be adopted here, as in the slighter cases of circulatory failure, is :

1. Withdraw the anæsthetic.
2. Rub the face and lips briskly with a dry towel.
3. Lower the head.

These simple measures will generally succeed. If they do not, the case must be treated as one of respiratory failure.

Care must be taken to distinguish between feeble breathing, which is merely the result of too light an anæsthesia, and that which precedes danger. The distinction is generally easy, for shallow, feeble breathing indicates danger only when it is present with—

1. Marked slowness, or irregularity or feebleness of pulse.
2. Marked change of colour, to lividity or pallor, in the face.
3. Insensitiveness of cornea.
4. Generally, if these symptoms mean danger there is also a dilated pupil.

Moreover, since the dangerous condition usually arises from a gradual overdosing with chloroform, the length of time that the anæsthetic has been administered, and the general state of the patient at the start, will help to guide the anæsthetist. The pupil alone is not a safe sign in these cases. It may remain small though the respiration is dangerously feeble.

Infants under chloroform are very liable to this condition of depressed respiration with pallor. It is rarely seen with ether.

Stoppage of the Breathing.—Whatever anæsthetic is being employed the treatment to be adopted is the same, and is summed up under the following heads.

The steps are to be taken in the order in which they are here given.

1. If the patient is not already on the back, with the head in a line with, and not above, the level of the shoulders, place him so. Turn the head to one side.

2. Open the mouth to half its full extent, and draw out the tongue with tongue forceps; pass a finger to the back of the pharynx, hooking forward the base of the tongue and the epiglottis.

3. Rapidly wipe out the pharynx with a small sponge.

4. Firmly compress the chest by placing one hand at each side of the sternum and then using the weight of the body. If breathing does not now start, while the operator or nurse keeps the tongue out and mouth open—

5. Again compress the chest.

6. Respiration being still in abeyance, seize the patient's arms, and carry out Sylvester's method of artificial respiration.

The two processes of inflating and squeezing the chest are to be slowly repeated, a pause being made after every compression, and the series of inflation, repression, and pause reiterated fifteen times in a minute until breathing begins. A deep sigh usually heralds the return of respiration.

A common mistake is to begin by inflating the chest. Expulsion of the air should be the first aim, because the suspended respiration is probably due to a too chloroform-laden atmosphere within the lungs. The movements also are not to be carried out too rapidly, as is likely to happen if there is alarm on the part of those concerned.

Accessories.—It is of the greatest importance to realize that the above are the essential steps to take. Artificial respiration is the great restorative of cardiac

action as well as of breathing, and valuable time must not be lost in less effectual efforts. Artificial respiration can, unaided, restore the patient when anything can; but if time is lost in getting drugs, performing injections, or administering enemata, these methods may fail, and the time will have gone by within which artificial respiration would have succeeded. Supposing, however, while the anæsthetist and operator are occupied with the performance of artificial respiration, and maintaining an unobstructed air-way, further hands are available, then accessory aids may be employed, if they are thought necessary, by—

1. Subcutaneous injection of ten drops of strychnine (1 per cent. solution). This must be given into the thigh or lower abdomen, so as not to interfere with the respiratory movements.

2. Rectal injections of 1 pint of water at 105° with 2 ounces of brandy.

3. Brisk friction of the face and gums with a dry towel.

4. Bandaging and raising the lower limbs.

If circulatory failure has occurred and the above steps have not restored animation, attempts should be made to stimulate the heart by—

1. Compression between the hands, one on the chest and the other pushing up below the left costal arch.

2. Electrical stimulation through needles passed in to the heart.

The *reflex effect* of the operation upon respiration is most often seen as a quickening and deepening of the breathing at the moment the skin is incised. If anæsthesia is not properly established, however, the commencement of an operation may lead to reflex spasmodic holding of the breath, which may in the case of chloroform be very dangerous, and which constitutes

the chief reason against allowing operation to begin before the third stage of anæsthesia is reached. Certain procedures, such as dilatation of the anal sphincters, forcible dragging on internal organs, etc., are very generally accompanied by a reflex effect upon the respiratory rhythm. The influence which the *patient's condition* may have in embarrassing respiration has already been alluded to in considering the appropriate anæsthetic for cases involving the chest, larynx, etc. The *position in which the patient is placed* may in like manner interfere with free performance of respiration, and lead to its depression or stoppage. This factor, too, is alluded to in detail (p. 101). In addition to what is there said, the student is reminded that in the *dental chair* patients are wont to stretch the head back instead of letting it rest in a natural line with the shoulders, that in operations upon *the kidney* firm pressure being made upon the abdomen sometimes embarrasses the breathing, and that very stout persons in the lithotomy position may be inconvenienced in a similar way.

In the operation of *laminectomy*, when the patient lies quite prone, respiration is best accommodated if, instead of allowing the face to press firmly against the table, the head is brought to project beyond its end. The anæsthetist must then support the head, which is laborious for him but advantageous to the patient.

Circulatory Failure is, in slight cases, to be treated by:

1. Withdrawing the anæsthetic.
2. Lowering the head.
3. Rubbing the lips and face.

These simple measures succeed in slight cases; they may be supplemented by the application to the back of the neck of towels wrung out in very hot water.

In more severe cases, where there is absolute failure of the pulse,

(i.) Cardiac compression,
(ii.) Injections of strychnine and of brandy,
(iii.) Transfusion (hemisine, 10 drops of 1 in 1,000 solution, may be introduced with advantage),

must be employed. If respiration has ceased, *artificial respiration is the most important step of all*, and must have the undivided attention of the anæsthetist. The steps necessary for the remedying of grave respiratory difficulty are also those which are essential in bad cases of circulatory failure, for the respiration then fails too.

Cardiac compression can be combined with the expiration movement of artificial respiration, and has appeared successful in at least one case of a child, which was otherwise hopeless (Hewitt).

The influence of the depth of anæsthesia upon the chance of surgical shock is doubtful, and it is probable that, provided consciousness is fully abolished and the third stage of anæsthesia established, a greater degree of anæsthesia does not further diminish the chance of shock at any particular moment. The collapse which may be present at the close of a long operation is to be regarded as a combined effect of the anæsthetic and the surgical procedure.

Warmth, a low position of the head, injections of hemisine, hot rectal injections and transfusion in the worst cases form the treatment.

Direct manipulation of the heart has saved some cases of cardiac failure. When the abdomen is already open this should always be tried, the previous measures having failed.

Vomiting coming on during anæsthesia may be

accompanied by marked depression of respiration as well as of the circulation. It is generally immediately preceded by swallowing movements, blueness or pallor of the face, and a dilating pupil. It is due to insufficient supply of the anæsthetic, and, if anticipated in time, may be prevented by a more liberal supply. In cases where much mucus and saliva are secreted, particularly some 'glands of the neck' cases, very deep anæsthesia can alone prevent the occurrence of vomiting during the operation.

When the *condition of the patient* is such as to render him particularly liable to collapse, as, *e.g.*, when a lengthy laparotomy is to be performed upon a person who has long been starved owing to a malignant growth of the stomach, special precautions to avoid shock should be taken. The warmth and covering of all those parts of the body not necessarily exposed by operation must be seen to; a rectal injection of hot water and brandy (1 pint to 2 ounces) may be given half an hour before operation; the anæsthetic is to be most cautiously used, and ether should play a part in it.

In cases of obstruction and of peritonitis, vomiting may be present independent of the anæsthetic. Such vomiting is often of a quiet, regurgitant nature, the material brought up being, thin black liquid, and particular care is necessary to avoid inhalation of this. The mouth should be kept open throughout, and the chest tilted to one side by a pillow placed behind the opposite shoulder. It is best to avoid the use of anæsthetics requiring an inhaler close against the face, lest the quiet vomiting should go on unobserved.

CHAPTER IX

THE QUESTION OF POSITION

In many operations the position in which the patient is placed has a most important bearing upon his safety, and a few words may now be said in addition to what occurs upon the subjects in Chapters VII. and VIII. The safest position is not always that which is quite the most convenient for the surgeon, and is, therefore, not always adopted.

The anæsthetist should seek to secure the safest position for the patient, and at the same time to do his utmost to make this most convenient for the operator. *In all cases where blood is liable to enter the pharynx, and so to be inhaled, the patient should lie upon one side,* the buttocks well over to the side of the table away from the surgeon, the upper thigh bent towards him, and the head and shoulders curved towards him. In this position, blood in the mouth and pharynx gravitates into the lower cheek, and is easily removed without causing inconvenience or danger. This position has been warmly advocated by Sheild and Hewitt, and is highly desirable in all operations—

1. Upon the tongue and jaws.
2. For adenoid growths.
3. For retropharyngeal abscesses.
4. For tumours or disease within the mouth, nose, or pharynx.

This lateral position, though the most safe, is not commonly adopted for operations on the inside of the nose. It is sometimes thought that the area of operation is not well seen while the patient is lateral, but in reality if the surgeon sits upon a chair and has light and mirror well arranged a perfect view may be obtained. These cases are often dealt with in *the sitting position*. The anæsthetist should then always have a gag in the mouth and a small sponge ready to swab out blood. It is generally best to get the patient well under ether before the operation begins and then continue the administration by Junker's inhaler, the tube lying in one side of the mouth. The coughing reflex may be abolished if the anæsthetist can easily sponge out the pharynx with sufficient frequency, otherwise the anæsthesia should be light enough to admit of coughing. Operations upon the septum, turbinated bones of the nose, and upon the antrum of Highmore, are included in this class. In the case of *tonsils and adenoids*, the patient being well under ether and the mouth widely opened with a gag, the tonsils are well seen and removed in the sitting posture, the anæsthetist steadying the gag and pushing forward the tonsils in turn from behind the angles of the jaw. Then the patient is laid over on to the side, the gag still being open in the mouth, and the adenoids are removed. Some operators prefer to remove the adenoids, too, while the patient is in the sitting posture, the head being then bent forward. The mouth is kept open for a minute or two till bleeding stops. Even with those surgeons who operate deliberately the ether anæsthesia, in the case of children at any rate, usually admits of the whole operation being completely performed. If not, chloroform is to be pumped into the side of the mouth from a Junker's inhaler, which must be at hand ready for

the purpose. Some surgeons prefer chloroform from the start for these operations on account of the smaller hæmorrhage. In that case it is best to have the child lying on the side from first to last, or on the back with the head turned well on the side. Either of these positions is preferable to that in which the head is extended over the end of the couch. If, as is preferred by some operators, the patient lies on the back, with the head in the middle line, frequent sponging of the pharynx is essential, and the anæsthesia should be light enough to allow coughing.

A side position is adopted by some surgeons for rectal operations, and answers admirably. Especially it offers less embarrassment to respiration in the case of very fat persons than does the lithotomy position. It is more conveniently adopted on the bed in which the patient is afterwards to lie than is the latter. The advantage of not having to carry the patient from couch to bed afterwards is thus gained.

Position is of primary importance in **operations for empyema or abscess of lung.** In these cases the patient must *not be placed upon the sound side.* To place him so is to court disaster. If the empyema or abscess bursts, as sometimes happens, into a bronchus, the only sound lung may be suddenly invaded, and the patient drowned. Such a catastrophe has occurred on several occasions. The patient does not become gradually asphyxiated, but seems to succumb suddenly as to syncope.

Generally in such cases the patient should lie upon his back, the side to be operated upon slightly overhanging the edge of the table towards the surgeon. When the incision is to be made far back it may be absolutely necessary to roll the patient slightly on to

his sound side. A very strict watch is then to be kept for the least respiratory embarrassment. In all these cases only a light degree of anæsthesia is to be maintained. The patient is to be sufficiently anæsthetized not to move when the skin is cut; afterwards very little anæsthetic is to be given. Coughing when the chest has been opened is often an advantage, as it helps to expel pus and pyogenic membrane, which it is the operator's aim to remove.

Whatever position is necessitated by the operation, anæsthesia should be induced in a position which gives the unaffected side free room for expansion. Then the change to the position necessary for the surgeon is to be slowly made, the effect on the breathing being carefully observed.

CHAPTER X

CHILDREN

CHILDREN over four or five years of age may, generally speaking, be treated on the same lines as adults as regards anæsthetics. That is to say, for ordinary cases the routine anæsthetic should be gas and ether or ether, a Clover's inhaler being employed.

The fear engendered by a close face-piece may, of course, require attention even in children of much greater age. The method then to be employed is considered on p. 76. In younger children, certainly in infants up to two years of age, it is rarely advisable to use a closed apparatus at all. It does not, therefore, follow that chloroform is the only agent to be employed. The fallacy is thoroughly exploded, though not before it cost many deaths, which declared children to be peculiarly immune to danger under chloroform. They are certainly much more easily anæsthetized with chloroform than adults, just as they are much more easily anæsthetized by gas or ether, or any other anæsthetic agent. In the same way they are much more easily fatally affected by chloroform, as the records of death under this anæsthetic will convince anyone who has not reaped the same conviction from his own observation. This is true in spite of the fact that an infant can sometimes be resuscitated from a condition from which in an

adult recovery would be impossible. It is the feeble muscular development of infants and children which render them in one way particularly favourable subjects for chloroform—viz., by rendering them far less liable to trouble from muscular spasm than are strong adults. It is particularly in the early stages that fatalities have occurred, and, as a routine measure, *chloroform alone should not be used for the induction of anæsthesia* even in infants. This is a safe general rule, to be broken only in exceptional cases (p. 85). The best way to start the administration in the case of an infant is by the use of the *C.E.* mixture. Ten drachms (four of chloroform and six of ether) are mixed and shaken up in the drop-bottle. Ten drops are sprinkled on a Skinner's mask, which is held 2 inches from the infant's face. The mask is brought gradually closer to the face, and drops added in such a way that a spot about the size of a halfpenny is kept constantly moist. At first an infant cries and moves its head about. The movements of the face are followed by the mask, the distance between the two being kept constant. Careful watch is kept upon the breathing, and the least holding of the breath is answered by removal of the mask till respiration goes on smoothly again. The face becomes flushed, the pupils dilated, and there is secretion of mucus and saliva, and the infant's trunk and limbs wriggle. This condition is soon followed by one apparently of unconsciousness. The anæsthetist must not now be deceived into letting the operation begin. This quiet state is not one of deep anæsthesia, and a painful impression will arouse the child to movement. The quiet breathing, abolished corneal reflex, and flaccid limbs now present are not evidence that the infant will keep still if operation is begun. To make sure this is so, pour ½ ounce of pure

ether on the sponge of a cone and apply it closely to the patient's face (Rowell). If there is no coughing or gasping the child is ready for operation. Another test is to sharply pinch the skin of the child's abdomen.

To continue the Administration.—If the operation is a short one, anæsthesia is best maintained by continued use of the ether and cone. Half a drachm is to be poured on to the sponge at frequent intervals—about once in three minutes suffices for a child under three years old. The cone is held over the nose and mouth, resting lightly on the face. The region of the nose and mouth should be smeared with vaseline to avoid the chance of blistering the skin. In this way infants are anæsthetized with perfect safety and convenience for short operations, such as circumcision, which provide a large number of the cases at this early age. For any operation that does not require more than fifteen minutes anæsthesia may be conducted on these lines unless there are special obstacles (pp. 85 and 88). The ether excites a good deal of mucous secretion, which must be wiped away from the mouth from time to time. Surprisingly little of the anæsthetic is enough to maintain proper anæsthesia, and, in spite of the gurgling sound of the respiration, no bronchitis or other pulmonary trouble follows these short administrations.

For longer Operations.—The objection to the use of ether for infants lies in its tendency to irritate the air-passages and in the serious nature of bronchitis in these very young subjects. This objection does not hold in the case of short administrations. It is probably of real weight when the question arises of a long anæsthesia, where ether alone is best avoided, and the mixture which was used for the induction of anæsthesia may wisely be used throughout. When, however, there is

any reason to fear collapse, ether may be used even for these long cases. On one occasion a boy of three was anæsthetized in this way for an hour and a quarter for the performance of a difficult hernia operation. No lung trouble of any kind followed.

When ether is given throughout an operation of some length to a child over two years of age, the cone should be replaced by a Clover's inhaler. This, with the indicator at '2,' may be applied as soon as crying, excited by the *C.E.* mixture, begins to die away.

When the child is known to be liable to bronchitis, or such is actually present, or in special operations (pp. 85 and 88), anæsthesia, having been induced by the *C.E.* mixture, is to be maintained by chloroform alone. This should be given from a Junker's inhaler of simple pattern.

CHAPTER XI

PREPARATION OF PATIENT FOR OPERATION—CONDITIONS OF OPERATION—AFTER-EFFECTS

Although general anæsthetics vary greatly in the frequency with which they are followed by unpleasant after-effects and in the nature of their effects, yet before the use of any of them, even of nitrous oxide, the proper preparation of the patient should be instituted. The best chance is thus offered for quiet anæsthetization and for perfect recovery and comfort after taking the anæsthetic. Although many people may, and do, take nitrous oxide shortly after a full meal without any ill result, it is better that they should take the anæsthetic with an empty stomach. Before a considerable administration with air or oxygen the same care as before ether and chloroform is advisable.

The chief points to be observed are :

1. The last meal should be at least six hours before the time of operation, and should be a light one.

2. An aperient thirty-six hours before operation.

3. Ordinary diet, but with no heavy meal during the two days preceding operation.

The best time for operation is the early morning. When such an hour is chosen the patient has no food after the meal of the preceding evening.

Before abdominal operations, especially those involving any part of the alimentary canal, even longer care with diet than that sketched above is desirable. Special sterilized food is used in such cases as gastro-enterostomy. Some surgeons give strychnine for some days before prolonged operation.

In the case of very feeble persons it may be desirable to allow liquid nourishment in small quantity at a less interval than six hours before the operation. Similarly a patient who is collapsed may be given ½ ounce of neat brandy fifteen minutes before the anæsthetic is administered. In the case of infants, the preliminary starvation must not be overdone. Three hours is usually the maximum interval to be allowed between the last feed and the operation. Collapse following operation on small children has sometimes appeared to be due to over-starvation.

Moving the Anæsthetized Subject.—It is sometimes necessary or desirable to anæsthetize the patient while in bed, and to move him on to the operating table afterwards. Whenever possible such a practice is to be avoided. When it is inevitable, the patient is to be deeply anæsthetized before the move is made. As a matter of routine the *position of the patient* should be on the back, with the head supported by a pillow and turned to one side. The head should always be in a line with the chest. Some people prefer several pillows. As many as their comfort demands may be allowed, and when anæsthesia is established the extra ones should be removed. The temperature of the room should be between 66° and 70° F. Only as much as is necessary of the patient's body is to be exposed. The rest is to be lightly, warmly, and loosely covered. Particularly in the case of infants is unnecessary exposure to be avoided.

In moving the patient back to bed all jolting, abrupt movements are to be avoided, and the head is to be supported. Want of care in these matters makes vomiting more probable. The room is to be darkened and ventilated without sudden lowering of its temperature. The patient is to be slightly turned on to one side, with a pillow behind the back to preserve that position. The head is to be slightly raised, and laid on its side. Unless a trustworthy nurse or other attendant remains with the patient, the anæsthetist should not leave until the reflexes are present and voluntary movements or sounds have occurred.

The after-effects which may follow any general anæsthetic vary according to—

1. The nature of the anæsthetic, and the extent to which it is given.

2. The nature of the patient and his condition at the time.

After *ether* there is generally, before consciousness returns, some vomiting of mucus, with a little, sometimes much, bile and gastric juice. If the administration has been short there is usually no further vomiting, though there may be a feeling of nausea. After operations of less than twenty minutes there is no vomiting at all in one-third of the cases. After long administrations retching may continue off and on during some hours, and there may be vomiting on several occasions. The taste of ether then lingers about the patient, even to the following day or two. Those patients who secrete mucus most profusely during operation vomit most afterwards.

The tendency to *lung troubles after ether* has excited much attention, and opinion as to the frequency of, or freedom from, such sequelæ is still divided. Though in

many cases, no doubt, these troubles, when they occur, are due to exposure of the patient during or after operation to draughts and sudden changes to atmosphere of a lower temperature, yet in certain operations undoubtedly the use of ether is more liable than that of chloroform to be followed by trouble within the chest.

Some of the cases of *chest troubles* after operation are most probably instances of small pulmonary embolisms, due to clots from veins ligatured at the operation (Menzies).

After chloroform, vomiting is less constant in its occurrence. Occasionally, however, vomiting after chloroform persists, and is more serious and depressing than that seen after ether.

The patient who requires the largest quantity of anæsthetic is, as a general rule, he who suffers least after it. Thus the big muscular man, accustomed to free living and much tobacco, is difficult to anæsthetize, but recovers quickly and without discomfort from the anæsthetic. Emotional disturbance, with crying out, weeping, and restlessness, may be expected during the recovery from unconsciousness of a hysterical woman. Incoherent, rambling talk is common with any patient at such a time. Headache sometimes follows both ether and chloroform.

Mental disturbance after anæsthesia may occur after any anæsthetic in those predisposed to such trouble.

Albuminuria to a slight extent may follow chloroform or ether, particularly the former, and *glycosuria* is a very occasional sequel. Under the term *delayed chloroform poisoning*, Guthrie has described cases, usually in children, in which persistent vomiting, delirium, and death have been associated with the presence of acetonuria.

After-treatment.—As a routine rule, no food is to be allowed for five hours after ether or chloroform. The first food taken should be some thin, hot liquid, such as tea, beef-tea, or soup. The patient's fancy may be taken as a guide. Strong, hot coffee, iced champagne, hot water with a large dose of sodium bicarbonate, are useful remedies for continued vomiting. In severe cases an injection of morphia has succeeded when nothing else controlled the vomiting. A handkerchief soaked in vinegar and held near the nose relieves some people.

The most important point in preventing vomiting, next to care of the stomach condition previously, is care in the administration, so that the least possible quantity of the agent is used compatible with perfect anæsthesia. Vomiting follows the administrations of the inexperienced more often than it does those of the expert.

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THE END

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